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MAKING BOUNDARIES AND LINKING GLOBALLY: “MATERIAL POLITICS” OF PHYTOSANITARY REGULATION ON MEXICAN MANGOS

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MAKING BOUNDARIES AND LINKING GLOBALLY:
"MATERIAL POLITICS" OF PHYTOSANITARY
REGULATION ON MEXICAN MANGOS

DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Arts and Sciences at the University of Kentucky

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ABSTRACT OF DISSERTATION

MAKING BOUNDARIES AND LINKING GLOBALLY:
"MATERIAL POLITICS" OF PHYTOSANITARY
REGULATIOIN ON MEXICAN MANGOS

This dissertation illuminates how phytosanitary (PS) regulations enable mango exportation from Mexico to the United States. PS regulations are technical and legal measures to prevent plant pests from proliferating or being transported to other places and are important regulatory mechanisms enabling the globalization of agriculture. My case study investigates how PS regulations enable Mexican mango exportation as an aspect of the globalization of agriculture, illustrating the consequences of PS regulations to humans and non-humans. More specifically, three research questions are posed: (1) How does the PS regulation network operate to draw distinctions between pest/non-pest, thereby enabling the export of Mexican mangos to the United States? (2) What values are associated with the PS regulation network, and what are the normative, moral, or ethical implications of the regulations? And, (3) How are the PS regulations in transition in the state of Sinaloa changing economic prospects for mango growers and packers to tap into global mango markets?

Theoretically, the analysis draws on a concept called "material politics," which claims that politics is enacted through not only discursive measures, such as statutes, but also physical embodiment by material beings. Thus, PS regulations are conceptualized as a materially heterogeneous network that establishes boundaries between pest/non-pest, thereby connecting distinct places, such as mango orchards and consumers. The material politics concept also suggests the emergence of socio-material "ordering" effects by regulations, such as values, morals, and norms, as well as unequal economic opportunities.

Nine months of ethnographic fieldwork in Mexico, which employed in-depth interviews, (participant) observations, and documentary research, yielded the following findings: (1) PS regulations as a network of governance (re)configured the production of the commodity, "disciplining" humans and non-humans to conform to the global regulatory order; (2) in this network, non-governmental entities played critical roles, fitting squarely with the recent neoliberal political-economic orientation in Mexico; and

(3) although the government's pest eradication program could improve market chances for growers, local political-economic circumstances, including small-scale growers' dependence on packers for marketing, still left substantial challenges for such economic prospects to materialize.

KEYWORDS: Phytosanitary regulation, Mango, Mexico, Material Politics, Globalization of agriculture

Kiyohiko Sakamoto

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February 24, 2012

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MAKING BOUNDARIES AND LINKING GLOBALLY:
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I dedicate this dissertation to my father,

Akihiro Sakamoto

(February 16, 1942 - July 4, 2008)

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List of Acronyms and Abbreviations

Note: Acronyms and abbreviations listed below, except "PS" and "AOA," are chosen from those that are commonly or officially used, or relatively popular technical terms, rather than my own creation. When a commonly used Spanish acronym is available, I used it unless its equivalent English acronym is also popular. For instance, "CESAVESIN" is a commonly used acronym of a Spanish name rather than its English translation. However, I used "NAFTA," a popular acronym of a English name, although its Spanish equivalent "TLCAN" is also popular in Mexico. Italicized names indicate Spanish words.

ALPP	**Area of Low Pest Prevalence**
ANT	**Actor-Network Theory**
AOA	**Actor Oriented Approach**
APHIS	**Animal and Plant Health Inspection Service**
ARS	**Agricultural Research Service**
AW-IPM	**Area-Wide Integrated Pest Management**
CAADES	***Confederación de Asociaciones Agrícolas del Estado de Sinaloa*** (Confederation of Agricultural Associations of the State of Sinaloa)
CESAVE	***Comité Estatal de Sanidad Vegetal*** (State Committee of Plant Health)
CESAVESIN	***Comité Estatal de Sanidad Vegetal de Sinaloa*** (State Committee of Plant Health of Sinaloa)
CFR	**Code of Federal Regulations**
CNC	***Confederación Nacional Campesina*** (National Peasant Confederation)
CONASUPO	***Compañía Nacional de Subsistencias Populares*** (National Company of Popular Subsistence)
DGSV	***Dirección General de Sanidad Vegetal*** (General Director of Plant Health)
EDB	**Ethylene Dibromide**
EMEX	***Empacadoras de Mangos de Exportación*** (Mexican Mango Exporters Association)

EPA	**Environmental Protection Agency**
FAO	**Food and Agriculture Organization**
FHAT	**Forced Heated Air Treatment**
FTD	**Flies per Trap per Day**
GAP	**Good Agricultural Practices**
GATT	**General Agreement on Tariffs and Trade**
HWT	**Hot Water Treatment**
IAEA	**International Atomic Energy Agency**
INEGI	***Instituto Nacional de Estadística y Geografía*** (National Institute of Statistics and Geography)
INIFAP	***Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias*** (National Institute of Forest, Agriculture and Livestock Research)
IPM	**Integrated Pest Management**
IPPC	**International Plant Protection Convention**
ISPM	**International Standards for Phytosanitary Measures**
JLSV	***Junta Local de Sanidad Vegetal*** (Local Plant Health Council)
LFSV	***Ley Federal de Sanidad Vegetal*** (Federal Ley of Plant Health)
LFMN	***Ley Federal sobre Metrología y Normalización*** (Federal Law about Metrology and Normalization)
MB	**Methyl Bromide**
MNC	**Multi-National Corporation**
NAFTA	**North American Free Trade Agreement**
NAPPO	**North American Plant Protection Organization**

NOM	***Norma Oficial Mexicana*** (Mexican Official Standard/Regulation)
NPPO	**National Plant Protection Organization**
ODC	***Organización de Certificación*** (Organization of Certification)
PFs	***Profesionales Fitosanitarios*** (Phytosanitary Professionals)
PFA	**Pest Free Area**
PRA	**Pest Risk Analysis**
PRI	***Partido Revolucionario Institucional*** (Institutional Revolutionary Party)
PS	**Phytosanitary**
PVI	***Punto de Verificación e Inspección Interna*** (Internal Verification and Inspection Point)
RPPO	**Regional Plant Protection Organization**
SAGARPA	***Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación*** (Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food of Mexico)
SCT	***Secretaría de Comunicaciones y Transportes*** (Ministry of Communications and Transportations)
SENASICA	***Servicio Nacional de Sanidad, Inocuidad y Calidad Agroalimentaria*** (National Service of Agriculture and Food Safety, Hygiene and Quality)
SIT	**Sterile Insect Technique**
SPS	**Sanitary and Phytosanitary**
TEFs	***Terceros Especialistas Fitosanitarios*** (Third-party Phytosanitary Specialists)
TNC	**Trans-National Corporation**
UAS	***Universidad Autónoma de Sinaloa*** (Autonomous University of Sinaloa)

UDV	***Unidad de Verificación*** (Unit of Verification)
USDA	**U.S. Department of Agriculture**
VHT	**Vapor Heat Treatment**
WTO	**World Trade Organization**

Chapter 1

Introduction

Through what process are mango fruits from Mexico made available to consumers in the United States? That is the question prompting this research. Mangos, one of the most consumed fruits in tropical areas, are now commonly found in supermarkets in temperate industrialized countries, such as the United States. However, the fact that mangos are available in this country might be an unlikely outcome since they are vulnerable to *Tephritidae* fruit flies, highly problematic pests, which the United States strictly controls. The U.S. government applies stringent phytosanitary (PS) regulations to mangos in order to prevent the pests from entering the country. Through investigating the PS regulations, or measures “designed to minimize the transport and spread of organisms harmful to plants by means of human activities” (Ebbels 2003:3), this dissertations sheds light on some behind the scenes mechanisms that enable mangos to become a globally traded commodity.

Using the case study of Mexican mangos exported to the United States, the following chapters will present the ways a variety of agents, including humans, devices, insects, and statutes, are assembled as a network of regulations that makes the fruit pest-free and thereby eligible for export from Mexico to the United States. Drawing on ethnographic research conducted in Mexico, this study also illuminates how the PS regulation network engenders values, moral expectations, and norms, and alters the prospects of economic opportunities for mango growers and packers to access markets beyond their own borders.

For my case study, I chose Sinaloa in northwestern Mexico as the principal field of research for two reasons: first, it is a major mango-producing state, and second, it is in transition in terms of PS conditions. To prevent *Tephritidae* fruit flies,[1] which are parasitic on many fruit crops, from being introduced to its territory, the U.S. government requires that Mexican mangos prove to be free from the pests. This has been made possible by the application of disinfection treatments, including fumigation with ethylene dibromide (EDB),[2] heat treatment, and irradiation. Hot-water treatment (HWT), the most common disinfection treatment for Mexican mangos, involves dipping mangos in hot water for a certain period of time to kill immature fruit flies. This practice became mandatory in 1986 and since then has been successfully applied in the export of Mexican mangos to the United States. Meanwhile, an alternative tactic that allows producers to export mangos to the United States is production in pest-free areas (PFA). A PFA is an established geographic area in which target pest species have been eradicated and pest-free status is maintained through diverse technical means. In Sinaloa, five municipalities were recognized as PFA in 2005 by the U.S. Department of Agriculture (USDA). Mangos grown in the PFA can be exported to the United States without additional treatments such as HWT. Several other municipalities in the central region of the state are awaiting official recognition by the United States as PFA, while active operations to eradicate the pest are in effect in the rest of the state, which remains non-PFA. This

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[1] More specifically, these species are Mexican fruit fly (*Anastrepha ludens*), West Indian fruit fly (*A. obliqua*), Zapote fruit fly (*A. serpentina*), Guava fruit fly (*A. striata*), and Mediterranean fruit fly (*Ceratitis capitata*).

[2] As detailed in Chapter 6, the use of EDB has already been abolished for health concerns in the United States.

arrangement of the PS regulations in transition makes this state an ideal site in which to observe dynamic changes of the regulatory landscape.

Theoretically, my exploration of the PS regulation network is guided by the concept of “material politics” (Law and Mol 2008) so as to illuminate globalization as a process that makes boundaries between “pest/non-pest.” Moreover, the PS regulation network links distant places through mundane practices, involving non-human “material” beings, and simultaneously creates and contrasts multiple *orderings* as effects of the material practices. In contrast with the term *order*, which suggests a static and fixed status, the term *ordering* implies that consequences are ever incomplete, temporal effects (Law 1994) that are captured as processes. Therefore, the PS regulation network can be understood as establishing boundaries between “pest/non-pest” objects, places, and people, while simultaneously linking (i.e., establishing relationship between) them (e.g., a mango grove in Mexico and a supermarket in the United States). This process engages a variety of measures, including legal statutes and physical devices, involves human and non-human beings, and simultaneously creates socio-material orderings, including, as alluded to earlier, values, moral/ethical/normative senses, and disciplines, dominations, and inequalities. For instance, processes to distinguish whether fruits are free from pests are paired with other estimations, such as “a good grower producing pest-free fruits”; the “good” status implies a normative and disciplining expectation (e.g., “other growers should do the same”) as well as a qualification to market the products to distant places.

Thus, the material politics concept is a starting point to critically scrutinize the PS regulation network. However, ensuring that mango fruits are “pest free” is not a simple task. A variety of measures, including legal texts, scientific knowledge, pest detection devices, disinfection equipment, and people, must be allied, organized, and monitored to effect proper operation of the regulations. To better understand this complex process of assembling a heterogeneous regulation network, my study draws on insights from various strands of literature, including Science and Technology Studies (STS), Actor-Network Theory (ANT), Niklas Luhmann's systems theory, Michel Foucault's theories of governmentality, and the sociology of agriculture and food, in order to elucidate the performance and consequences of the PS regulation network as one of several regulations that enables today's globalization of agriculture and food production and consumption. Insights from STS and ANT in particular propose that both humans and non-humans be treated symmetrically in analysis of the "social" as a materially heterogeneous network (Law 1994; 2009). System-theoretical perspective is useful in accurately grasping specific operations of functionally differentiated social systems, such as science, law, economics, and politics, which are assembled as a network and altogether serve to enact the PS regulations. That global society has distinctive domains, or differentiated systems, is also relevant to understanding the recent rise of governance and governmentality under a neoliberal political climate, which drives the globalization of agriculture and food production and consumption. Foucault's concept of governmentality indicates that in neoliberal political-economic reforms the nation-state government gradually loses—or so it appears—its central role in regulating society. In its place arises scientific governance and diverse entities involved in governance as significant players, including non-governmental organizations (NGOs), as well as the use of a variety of technical measures and expertise underpinned by varying social domains, such as science and law, in order to "conduct conducts" of individuals (Barry, Osborne, and Rose 1996a; Dean 2010; Higgins and Larner 2010; Higgins and Lawrence 2005a; Irwin 2007; Rose and Miller [1992] 2010). My research of the PS regulation network for the export of Mexican mangos is situated in conjunction with these various theoretical strands.

In the rest of this chapter I will provide a brief overview of the background of the present study. This will include an outline of the PS regulatory program for the mango export program in the state of Sinaloa and formulation of the research questions for the dissertation. Then, an outline of the dissertation will follow with brief descriptions of each chapter.

1.1 Background of the Research and Research Questions

The mango is an important global agro-commodity generating revenues for people of developing countries (Jacobi, MacRae, and Hetherington 2001). However, its international trade is relatively limited due to its susceptibility to destructive fruit flies and perishability, resulting in the necessity of post-harvest PS treatments for disinfection that can simultaneously preserve the fruit's quality (Jacobi, MacRae, and Hetherington 2001). Mexico is a major mango-producing country, ranked fourth in world total production, and exported about 0.2 million tons of mangos in 2005, ranking second in the world's total export in that year (FAOSTATS http://faostat.fao.org/). The US is the most important customer of this export from Mexico: nearly ninety percent of the mango export from Mexico is destined for the United States.

In the fresh mango exportation from Mexico to the United States, PS regulations to ensure that fruits are pest-free are crucial. Mexican packers/exporters shipping mangos to the United States must abide by the Work Plan agreed upon by the U.S. Department of Agriculture's Animal and Plant Health Inspection Service (USDA-APHIS) and the

Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (SAGARPA) of Mexico. The Work Plan details technical specifications of the disinfection of the fruit, as well as the responsibilities of APHIS, SAGARPA, growers, packers/exporters, and their organization, *Empacadoras de Mango de Exportación* (EMEX). As the only organization officially recognized by the USDA as representing the exporters, EMEX is responsible for coordinating key activities of the program. Since its foundation in 1991, EMEX has been vital to the promotion of almost all aspects of the Mexican mango industry, including research on mangos, quarantine negotiations, post-harvest handling, packing standards, marketing, and promotion of the commodity (Wong-Urrea et al. 1996).

Hot-water treatment (HWT) is the practice used for disinfection in most of the areas where mangos are produced in Mexico. This practice draws distinctions between pest-free fruits and non-pest-free fruits and links them (i.e. pest-free fruits can be exported) to the United States. The process engages diverse means and material beings such as a water tub, hot water, thermometer, and so forth. In addition to the HWT process *per se*, the Work Plan, along with national PS statutes, stipulates numerous conditions, including registration of orchards, certification of disinfection facilities, monitoring of packing, and on-site inspection by APHIS and SAGARPA officials. While the practice of HWT engages diverse human and non-human beings, it engenders certain orderings about and among them, such as "*clean* packing areas for treated fruits" and "*non-clean* unload areas for untreated fruits" within a packing/disinfection facility. The HWT currently practiced was initially developed in the 1980s. Prior to that, as detailed in Chapter 6, mangos were disinfected with vapor heat, fumigation by EDB, or another technique combining vapor heat and cold water (Sharp et al. 1989; Sharp 1994; Sharp and Hallman 1994).

Meanwhile, pest-free area (PFA) certification is an alternative means to authorize Mexican mango exportation to the United States. A PFA is described as “an area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained” (IPPC 1995:37). To eradicate a target pest species from a certain geographical area, and to establish and maintain it as pest-free, various measures are applied, including pest monitoring by traps, pest population suppression by sterile fly release and pesticide application, and other quarantine measures such as roadside inspection (Riherd, Nguyen, and Brazzel 1994). The fruit flies of concern in Mexico, consistent with the fact that Mexican fruit flies are the best known species of fruit fly, are persistent and elusive as they can reproduce in different plants, can fly, or can “hitchhike” on human transportation, sneaking into another area. Hence, to eradicate them from a geographic area takes tireless and repeated mundane practices. The area in which a pest species is eradicated must be officially (i.e., by a national government) certified and declared to be pest-free by exporting and importing countries to make products eligible for export.

In the case of mangos, the benefit of PFA certification is significant because fruits grown in a PFA can be exported without HWT, which is costly and can damage fruits’ quality. In 2005, the Mexican governmental eradication campaign led to the official recognition by the United States that five municipalities in northern Sinaloa were free of fruit flies (SAGARPA 2006). Critical to my study, this PFA’s “frontline” is about to shift: several other municipalities are awaiting official recognition as PFAs. This changing arrangement of PS regulations provided me with a chance to closely analyze the dynamism of different modes of ordering effects between HWT and PFA. It could be posited that the shifting technical arrangement from HWT to PFA in Sinaloa would allow me to delineate multiple, asymmetrical, contingent emerging orderings, which may entail moral and normative values, and differential economic opportunities. For example, currently several roadside inspection points operate in Sinaloa to prevent smuggling of potentially *contaminated* items into the *clean* PFA. Transportation of humans and non-humans are controlled here; passing the points with banned products potentially contaminated with fruit flies can now be deemed *illegal*. In the area where fruit fly control programs operate, some mango growers who are *serious* about complying with practices required for pest control blame those who are not for being *unserious*. A field technician who checks fruit fly traps carefully and never misses the detection of problematic insects would be deemed *competent*, while others who have missed would be called, unfortunately, *incompetent*. In the area that is becoming a PFA, some mango growers see *opportunities* to ship their fruits without the costly HWT, but others find costs for the eradication program *constraining*. And the differences can result in varying opportunities to gain access to the global economy of agriculture.

In addition to the technical transition of the PS regulations in Sinaloa, my study addresses how scientific knowledge about fruit flies and measures to control them are constructed. Scientific research on fruit flies is where distinctions between "pest/non-pest" are produced. It is one of the tasks of this study to elucidate how scientists examine whether a certain class of insects is a significant pest for particular crops, or whether technical measures such as HWT can really make fruits pest-free. For example, determining “host status” (i.e., whether a plant product can be infested by a certain class of insect) is not a straightforward task. Host status is a complex function where diverse variables intertwine, including the plant’s and the insect’s ecological and physiological characteristics and the politico-economic concerns of countries interested in the trade of plant products (Aluja and Mangan 2008). In the case of a fruit fly, whether its larva hatches, grows, and feeds on a specific fruit is one of the primary determinants of host status. However, some fruit flies’ feeding habits are fairly contingent on diverse factors, such as the availability of plants and the characteristics of fruits. Even if a fruit fly species is known not to lay eggs on fruits of a particular plant in the wild field, it may do so in an artificial condition (i.e., confined in a cage with only a concerned plant species or cultivar). As for the development of the HWT, a trial-and-error process is necessary to determine the appropriate water temperature and time of dipping fruits while ensuring both disinfection and quality (e.g., palatability and shelf life) of fruits. A variety of factors determine the parameters of the HWT, such as the size of fruits, their heat tolerance in terms of quality preservation, and the heat resistance of larva at different developmental stages.

Not only “natural” scientific-technical aspects, but also “politics” comes into play in regulating fruits for exportation. Fruit growers in the United States might be concerned about potential fruit fly invasions as a result of allowing the importation of new fruit products, including mangos. For exporting countries, such responses might appear to reflect protectionism on the part of U.S. farmers. Even if an importing country lifts a plant-quarantine import ban, it does not mean that all producers in the approved exporting countries can immediately export the product. An exporting country and an importing country make an agreement that requires specific conditions for export, which some farmers may find difficult to meet.

The technical transition of PS regulations in Sinaloa as well as basic scientific research on fruit flies both constitute processes that draw pest/non-pest distinctions, engaging not only humans but also non-humans. To an observer examining scientific research on fruit flies, the processes to construct knowledge, whether host status determination or development of HWT, may look as if "negotiation" between humans and non-humans, such as fruits, pests, humans, and devices, is taking place. With the guidance of the idea of material politics, this study aims to elucidate how such "negotiation" as *socio-material ordering* is taking place and being settled, and what consequences the PS regulations bring about, including moral, normative senses, and differing economic opportunities. More specifically, I ask the following questions:

[Question 1] How does the PS regulation network operate to draw distinctions between pest/non-pest, thereby enabling the export of Mexican mangos to the United States? Who and what devices, practices, or knowledge are applied in the development and enactment of PS regulations?

[Question 2] What values are associated with the PS regulation network, and what are the normative, moral, or ethical implications of the regulations?

[Question 3] How are the PS regulations in transition in Sinaloa changing economic prospects for mango growers and packers to tap into global markets of mangos?

1.2 Outline of Dissertation

The next chapter will develop the theoretical foundation that guides this study. I will provide an overview of the material politics concept by Law and Mol (2008) and explain how it is applied to the analysis of PS regulations in Mexico. Then, my analysis of the material politics of the PS regulation network will be situated in various strands of relevant literature, including political economy of governance, systems theory, STS, and the sociology of agriculture and food. Chapter Three will address methodologies employed in this research using a case study approach, consisting of qualitative data collection and analysis approaches. Chapter Four will introduce major "actors" in this research, including legal and organizational frameworks of global PS regulations, *Tephritidae* fruit flies, and mangos, and settings of the research site, Sinaloa, Mexico.

From Chapter Five through Ten, findings from the fieldwork in Mexico and analyses of document data will be presented. Chapter Five will analyze a few cases on processes through which a certain class of fruit flies were determined as a pest vis-à-vis specific plant crops. Particular analytical attention will be paid to how uncertainties of behaviors of the concerned fruit flies are handled, or temporarily halted and concealed, so that knowledge about the pest-host relationship is built and sustained.

Chapter Six and Seven will examine major PS measures that enable the export of Mexican mangos to the United States. Chapter Six, first, will trace a historical trajectory of the development of post-harvest treatments, such as HWT, since the 1950s. A detailed document analysis will elucidate how PS regulatory technologies developed, evolved, and/or were abolished, engaging a constellation of human and non-human agents, including devices and statutes, building and (re)shaping social-material relationships.

Following the analysis of post-harvest treatments is Chapter Seven, which presents how the PFA in the state of Sinaloa was (being) established, by a national pest eradication/control campaign, which employs a variety of "discursive" (flexible and mobile) means and more rigid "material" means, along with non-human agents such as sterilized insects and natural enemies of the pest. Processes to establish and maintain the PFA, as the core component of the national campaign, are complex and extensive, expanding the campaign's reach of control from mango-producing areas to even non-farming areas including urban residential zones, due to the high mobility of the fruit fly pests. In short, the PS regulations for the PFA spatially expand, going beyond mango groves and packing houses. These two chapters also elucidate how some of the physical settings, for instance, double-screen doors installed in a packing house to control movements of humans and non-humans, and simultaneously demarcating pest/non-pest zones, were incorporated in PS regulations as a materially heterogeneous network, epitomizing what the material politics concept is meant to capture through its analysis.

Chapter Eight will focus on some of the major organizational actors in charge of PS regulations. Findings from my fieldwork will reveal important roles of quasi-governmental organizations, in particular, *Comité Estatal de Sanidad Vegetal de Sinaloa* (CESAVESIN), or the State Committee of Plant Health of Sinaloa, in regulatory activities to control the pest in Sinaloa. The unique, hybrid characteristics of this Committee as a semi-private-semi-governmental organization enable it to engage in strict regulatory activities with legally delegated authorities, and at the same time to effectively mobilize mango growers to carry out control practices. Besides this Committee, the increasing presence of other non-governmental third-party bodies playing vital roles in the enactment of PS regulations, such as the inspection of fruits in packing houses, will be examined as well. My argument will center on the aptness and flexibility of these quasi-governmental agencies in enacting the regulations very effectively within the neoliberal political climate resulting from Mexico's recent political-economic reforms.

Chapter Nine will address the values and moral, ethical, or normative implications that constitute corollaries of the PS regulation network, and serve to discipline those who/that are involved in it. Also addressed in this chapter are potential and explicit conflicts engendered through confrontations of varying interests of actors engaged in the regulation. Chapter Ten, the final chapter presenting findings, will examine whether and how the PS regulation network will benefit some actors, such as farmers, especially small-scale, less-resourceful, peasant growers. This question also pertains to how national PS regulations as a public campaign incurring substantial costs is justified with its expected benefits. That is, the eradication program of the PS campaign is expected to eliminate the costly HWT, thereby supposedly liberating growers from a dependent relationship with packers possessing the disinfection treatment equipment. However, in reality, whether the economic prospect that growers would soon benefit from "liberation" from the pest hinges on complex politico-economic circumstances surrounding peasant growers, including increasing fees to participate in the pest-control program. Rather, my argument will be that assessments of the prospected benefits of PS regulations require consideration of the complex conditions in which peasant growers strive to sustain their livelihoods.

Chapter Eleven, the concluding chapter, will provide summaries of the findings chapters, followed by discussions of the significance of as well as limits of this research.

Based on this, I will suggest future directions for subsequent inquiries to advance understanding of global regulatory governance in agriculture and food provision.

Chapter 2

Material Politics: Theoretical Framework and Literature Review

This chapter addresses the theoretical foundation for the present research. First, I will spell out the concept of material politics (Law and Mol 2008) and how it will guide this study. Inspired by the practice of boiling pig swills in the United Kingdom as a "political technique," the concept draws attention to politics enacted by both "material" and "discursive" means, as well as the multiplicity of socio-material orderings as outcomes of a political technique. Second, I will discuss how the material politics concept can be related to relevant literature, including works on STS, systems theory, and the sociology of agriculture and food. A key idea that bridges these strands of literature is governance in (neo)liberal political climates reflecting functional differentiation of modern society, which, I will argue, provides diverse resources of legitimacy for regulations to be assembled as materially heterogeneous, spatially and institutionally extending, networks of control over human and non-human beings.

2.1 Material Politics

First and foremost, I will begin with the leitmotif of this study, that is, material politics, which "may be understood as a material ordering of the world in a way that contrasts this with other and equally possible alternative modes of ordering" (Law and Mol 2008:133). As mentioned in the first chapter, *ordering* here means to defy the notion of an order as a static status and to highlight that it is an ever incomplete and temporal outcome (Law 1994). Law and Mol presented the concept of material politics through the case of boiling treatment of pig swills (i.e., food waste), which drew distinctions, establish boundaries, and connect different locales in the United Kingdom. The practice of boiling, which Law and Mol consider a “political technique,” was a legally required mundane practice to disinfect human food waste and convert it into clean feed to prevent swine disease. The practice involved non-human beings (e.g., boiling water, swine, and waste from restaurants) all of which worked together to make links (i.e., establishing relationships between) different places and times of metabolism, while engendering multiple orderings of the world. Through boiling, multiple ordering effects such as those between “food waste versus clean feed,” “disease-free, high-productive, rich United Kingdom (where this treatment was practiced) versus contaminated, low-productive, poor countries (where the treatment is not applied),” were engendered. However, this practice was abolished in 2001 when Foot and Mouth Disease, a devastating cattle disease, occurred, perhaps due to improper boiling treatment of swills. The abolishment of the boiling practice in 2001 raised feed demand in the United Kingdom, which boosted soy production in Argentina. At this time, the United Kingdom became dependent on Argentinian feed supplies; and following this new ordering were workers who lost jobs in rural Argentina, since soy production required less labor. Also, the metabolic linking through recycling food waste between humans and hogs was severed in the United Kingdom. The boiling practice as a political technique “ordered metabolic relations in a complex way, globally dividing the rich from the poor, linking up distant places and peoples” (Law and Mol 2008:141).

Thus, the idea of material politics concerns “an analysis of a geologic (a geologic that is also an anthropologic and a technologic) of connecting and disconnecting; of linking and differentiating while foregrounding the material specificities of our geographically dispersed site” (Law and Mol 2008:134). Put differently, material politics allows us to grasp globalization as a process that draws boundaries and links distant places through mundane practices involving both humans and non-humans and to contrast contingent orderings of the world as effects of such material practices.

A very important feature of the material politics concept is its attention to "materiality." According to Law and Mol, there are two different sorts of politics: one that is associated with "material" artifacts such as sleeping policeman (i.e., bump installed on street to slow car speed down); the other associated with debates, discussions, or explicit contestations, epitomized by political life in the ancient Greek polis. The former is derived from insights of STS/ANT (Latour 1987; 2005; Law 1994; 2009; Law and Hassard 1999), whereas the latter is from Hannah Arendt's political philosophy (Arendt 1958). For Law and Mol, one kind of these "politics" is not sufficient to grasp material politics. The former is too strongly linked to a single order, that is, merely whether a sleeping policeman slows a car down or not. The latter seems too strongly tied with "the life of the mind" and is indifferent to the "stubborn obduracy of the material" (Law and Mol 2008:134). Law and Mol (2008) articulate the material politics concept as "one that simultaneously foregrounds the relevance of materialities, whilst making it possible to explore differences and alternative modes of being" (135).

Also, the material politics concept takes seriously the relevance of non-human beings in creating orderings of the world in relational, multi-contextual realities. In other words, an ordering effect is not a single causal consequence, but is understood as one of many possible alternative consequences in different contexts. Accordingly, it can be argued that it is the task of an observer (a researcher) to elucidate and problematize as "politics" contingent ordering effects that are consequences of the mundane working of non-human "actors." An "actor" here is defined as an entity, whether human or non-human (e.g., a pest, nature, or god) and "collective" or not (e.g., an organization, government, or individual), to which an event is attributed as its "act." In the meantime, I will call any unity to which an event may or may not be attributed as its act an "entity."

Further noteworthy is their concept of ordering, which is comprehended in its multiplicity or contingency. Material politics may be construed "as a material ordering of the world in a way that contrasts with alternative and equally possible modes of ordering" (Law and Mol 2008:133). This statement encapsulates their attention to the plural-contextual realities of modern society. Also, an ordering is conceptualized as an ever-incomplete process. The idea of material politics aims to delineate globalization as ordering rather than a fixed static order, because what is observed is not something ever-stable but an ever-incomplete process. Moreover, this pertains to their attention to the mundaneness of practices that engender orderings. The boiling practice as such was not necessarily something interesting, exciting, nor hotly contested (at least until it was questioned). Yet, it is the very mundaneness of the practice that kept enacting boundaries and simultaneously enabling linking, hence socio-material orderings.

Finally, I highlight what I call the "reflexive constructivism" of the material politics concept, that is, the recognition that the "question is not whether something is political all by itself but whether it can be called as part of the process of analysing it" (Law and Mol 2008:133). Observing and describing something cannot be separated from how an observer sees it (Luhmann 1998). Such a stance refuses a simple ontology that presumes objects to be observed "exist out there" independently from how an observer sees it.

Thus, it is my task to observe, thematize, and problematize the network of PS regulations for Mexican mangos as material *politics*. Following the discussions of Law and Mol, I posit that the network of PS regulations, as material politics engaging human and non-human beings, work to put things, practices, and people engaged in the regulations into certain orderings. These PS regulations are conceptualized as establishing boundaries around pest-free things or places, while simultaneously linking them to different locales. For instance, mangos are processed with mundane practices, such as hot-water treatment, to be made pest-free; then, they become eligible to be shipped to distant places. The PS regulation network, involving both human and non-human beings, put them into certain orderings. That is, besides pest versus pest-free (non-pest), other orderings may emerge including values or norms (e.g., desirable vs. undesirable production practices) or other distinctions (e.g., a mango packer entitled for export vs. a mango grower unauthorized for export), contingent on context. These orderings also occasion asymmetrical consequences for people, products, or places in terms of likeliness to gain access to and benefit from the globalization of agriculture. For instance, some growers and packers who produce pest-free mangos with desirable practices become suppliers who are most likely to benefit from exporting the commodity, whereas others who do not or cannot produce pest-free products are not eligible to do so. I note, further, that my study reflexively constructs PS regulations as politics; that is, it thematizes and illuminates how mundane practices associated with the regulations create socio-material orderings that entail asymmetrical power, or dominance/submission relationships, among those involved in it. Sociologists concerned about the impact of regulatory mechanisms of agri-food globalization have been revealing such unequal consequences for rural people (Bain, Deaton, and Busch 2005; Echánove 2005; Stanford 2002). Developing from the work of material politics, this study will elucidate how performances of PS regulations draw boundaries and are enacted, and what consequences these regulations have brought to involved parties.

2.2 Situating PS Regulations in Governance

Alongside the theoretical foundation discussed above, in what follows I will situate my study of PS regulations in conjunction with relevant literature in the social sciences. To do this, I will briefly examine the concept of governance based on Michel Foucault's argument, which reflects the shift of dominance from the nation-state to diffusive and diverse mechanisms. In the governance scheme of regulating society, especially under a neoliberal political climate, a constellation of technical or legal measures are employed. These measures produce self-discipline through moralizing and normalizing individual human subjects, or inducing them to become productive actors conforming to global regulations (Burchell 1996; Jaeger 2007; Rose 1996). Bringing the governance concept to my analysis connects the changing regulatory scheme under neoliberal governance to the previous discussion of material politics, underpinned with ANT and systems theory. The "governance shift" in global regulations, I argue based on insights from systems theory, reflects the increasing complexity of modern society where functionally differentiated systems, such as, and especially, science and law, provide legitimacy to expert knowledge employed by diverse regulatory bodies, including NGOs. Further, based on ANT, a regulatory network can be comprehended as an assemblage of heterogeneous regulatory entities, whether humans or non-human, whether verbal commands or physical settings, extending beyond space and institutions to regulate a variety of entities “at a distance” (Irwin 2007). Also, the systems theory understands differentiation or segmentation of a regulatory network into heterogeneous entities in response to increasing complexity and uncertainties regarding the objects it is to deal with (Esmark 2009). Thus, it is my argument that ANT and systems theory, both combined with literature in political economy, allow a more profound understanding of the transformation of regulatory governance in the globalization of agriculture and food production and consumption, than when a single strand of these literatures is employed.

2.2.1 Governance shift

The concept of governance has been drawing increasing attention within the social sciences since the 1970s; however, its first use can be dated back to the fourteenth century and generally referred to “the action or manner of governing, guiding or steering conducts” (Jessop 1995:309). While the concept entails considerable ambiguity, there seems to be a broad consensus that it indicates a shift from a nation-state-centered regulatory scheme to regulation through the application of a variety of non-state entities and actors (Higgins and Lawrence 2005b; Jessop 1995). As the governance shift entails deterritorialization (i.e., uncoupling of regulation from the sovereign territory of a nation state) and proliferation of international organizations such as WTO and multi- or trans-national corporations (MNC and TNC, respectively), oftentimes discussions on governance revolve around globalization (Peine and McMichael 2005). In a similar vein, critics argue that privatization and decentralization of a central government’s agencies result in the emergence of new types of entities, such as quasi-governmental organizations, NGOs, and “third-party” certifying, auditing, or standard-making bodies, all of which are active at both local and international levels (Hatanaka, Bain, and Busch

2005). I argue that these commentators capture the increasing complexity of entities and actors involved in regulation and the broadening foci of objects to regulate, conditions that demand extending regulatory networks to transcend spatial and institutional boundaries.

Such shifts toward more diffusive regulatory networks are often ascribed to Michel Foucault's idea of governmentality in liberalism and neoliberalism (Barry, Osborne, and Rose 1996a; Dean 2010; Foucault 1991; Jaeger 2007). Foucault observed that the emergence of the modern state since the eighteenth century ushered governments to a new kind of practice, or art of conduct of conducts (Dean 2010; Foucault 1991). Ideas, or mentalities, of conducting conducts by government, that is, governmentality (Dean 2010; Rose and Miller [1992] 2012) in the eighteenth century was challenged by liberalism, which attempted to minimize top-down control by the government's authority over individual acts, especially in the economic domain (i.e., market), such that individual humans, deemed to be naturally endowed with freedom, would act freely yet in a well-coordinated and responsible manner (Barry, Osborne, and Rose 1996b; Rose 1996). Accordingly, the focus of governance was on technical means to induce self-discipline and conduct surveillance to monitor human acts, in tandem with the "concerns of political economy and 'liberalism' (that is, societal and individual self-regulation)" (Jaeger 2007:260). Therefore, Foucault's rejection of nation-state government as the sole regulator indicates growing interest in technologies of power to control the self, which "serv[e] to produce specific forms of disciplinary normalization and to codify or co-ordinate through governmental or governance mechanisms" (Jessop 1995:311).

Furthermore, in the post-World War II era when neoliberalism emerged, the liberal concern with techniques for self-discipline came to alter the notion of human freedom (Rose 1996). While the old liberalism considered human beings naturally endowed with intrinsic freedom, now neo-liberalism deems freedom an artifact, hence humans are subject to manipulation so that they can fully develop the capacity of free choice, becoming entrepreneurial and effective in many aspects of human life beyond the market/economic domain (Burchell 1996; Dean 2010; Gordon 1991). Accordingly, neoliberalism does not simply prioritize securing freedom in the economic domain, but in fact neoliberalism has multifaceted and complex applications beyond the economy (Jessop 2002; Peck and Tickell 2002). The plurality or multifacetedness of neoliberalism therefore indicates that "it is necessary to analyse particular forms of political rationality and the ways in which they connect themselves to regimes of government" (Dean 2010:73).

2.2.2 Functional differentiation, assemblage, and the governance shift

My argument here is that the multifaceted neoliberal governmentality extending beyond the economy (market) indicates that there are different systems with distinctive functions in society, that is, the functional differentiation of society (Albert 2007; Esmark 2009; Jaeger 2007; Jessop 1995; 1998; Kerwer 2004). The concept of functional differentiation, or functionalism, originating from the division of labor in society by Durkheim and adopted by Parsonsian structural functionalism, calls to mind the analogy of a living organism, which consists of mechanisms to perform "basic functions," or fulfill the needs of, and thereby sustain, an organism's body (Collins and Makowsky 2005). Recent systems theories, including Niklas Luhmann's work, departed from this model by abandoning the idea of a function as a necessity in order to sustain society, and formulated it as a scheme with which to find alternative solutions that fulfill a certain condition or solve a certain problem (Jessop 1995; Nagaoka 2006). Modern society is characterized as a variety of differentiated, globally extending, functional systems, including science, politics, law, mass-media, education, religion, art, and so forth, each of which has its distinctive operation (Esmark 2009; Nagaoka 2006). For instance, science as a functional system is posited to fulfill the problem of making distinctions between truth/not-truth; such distinctions are alternative and thus contingent solutions (therefore, science can be seen as a field of contesting claims concerning true or not true). Different systems with "particular forms of political rationality," such as science and law, provide diverse discursive and technical measures, which are mobilized, assembled, and "connected themselves to regimes of government" (Dean 2010:73) and constitute spatially and institutionally diffusive regulatory networks.

The pluri-reality created by functional differentiation in modern society indicates that "govenmentalization" of the nation state vis-à-vis emerging liberalism required the coordination of a variety of expertise and technologies in order to extend control over individuals across a territory, while refraining from hampering individual freedom in economic activities. Rose and Millar ([1992] 2010) argue, "The inauguration of liberal societies in Europe accords a vital role to a key characteristic of modern government: *action at a distance* . . . Liberal government identifies a domain outside 'politics', and seeks to manage it without destroying its existence and its autonomy. This is made possible through the activities and calculations of a proliferation of independent agents including philanthropists, doctors, hygienists, managers, planners, parents and social workers" (278). Thus, political technologies drawing on rational calculations of human behaviors or thinking, including architecture, accounting, education, medicine, or insurance (Beeson and Firth 1998), would proliferate so as to extend a network of measures disciplining individuals at a distance. With the emergence of neoliberalism, such networks of rational and calculated disciplinary measures expand beyond the economic domain, resulting in marketization of many, if not all, aspects of social life. Accordingly, by analyzing "the complex of mundane programmes, calculations, techniques, apparatuses, documents and procedures through which authorities seek to embody and give effect to governmental ambitions . . . we can begin to understand the multiple and delicate networks that connect the lives of individuals, groups and organizations to the aspirations of authorities in the advanced liberal democracies of the present" (Rose and Miller [1992] 2010:273-4). Law and Mol's material politics concept is precisely meant to capture this complex of assembled diverse measures, which is built as a materially heterogeneous network. Therefore, a key to understanding the governance shift in increasingly complex modern society lies in careful examination of how a variety of technical measures underpinned with differentiated expertise are assembled as a network so that governance extends its reach of subtle self-disciplining mechanisms over individuals spatially and institutionally.

Yet, the assemblage of heterogeneous entities by no means happens "smoothly." According to the systems theoretical perspective, different systems can be connected, or in Luhmann's term, "structurally coupled," with varying degrees of compatibilities, developing only particular paths of connections (Luhmann 2009b). For instance, while science, with its supposed objectivity, is increasingly incorporated into legal or administrative decision-making as a basis for unbiased judgment (Irwin 2007; Jasanoff 1995), other systems, such as religion or art, do not seem to be expected to play such roles. Assembling of a network would likely engender problematic corollaries as well; even if science is incorporated in administrative decision-making, scientific-technical rationality is incompatible with the latter, which oftentimes has to consider public reactions to a decision (Jasanoff 1987; 1995; Komatsu 2003). Thus, political reactions to scientific judgment may appear as irrational and distort its objectivity (Aluja and Mangan 2008).

Also, drawing on evolutionary theories, Luhmannian systems theory postulates the possibility (not necessity) of further differentiation within a system, that is, subsystems, which increase internal complexities (Nagaoka 2006). Such internal differentiation may (though not necessarily) occur as “segmentation (the differentiation of similar units), stratification (the differentiation of hierarchical strata), and center-periphery differentiation” (Jaeger 2007:261). The evolutionary changes can be comprehended, as Jessop (1995) argues, as self-organizing (i.e., self-constructing, self-reproducing, and self-steering) mechanisms of complex systems vis-à-vis difficulty in directly steering complex systems in a top-down manner by the nation-state government, reflecting the above discussed shifting regulatory governance. The evolutionary changes resulting in increasing subcomponents within a particular network, such as PS regulations, can be comprehended as adaptations to handle increasingly complex problems. For instance, PS regulations may add new standards or procedures, increasing internal complexity within it, to cope with increasing diversification of traded products, exotic pest species, or new technologies.

With this differentiation perspective, I make the case that PS regulations intersect with different systems and are supplied with foundations of these systems' legitimacy, such as "objective" scientific knowledge, legal authorization to enforce rules, and calculation of economic benefits, including those for consumers, and so forth. Following ANT's terminologies (Callon 1986), this process by which "feeds" from different systems are assembled through problematization, interessment, enrollment, and mobilization, involving non-human beings (e.g., physical constructs), thereby develops particular paths between different systems. Moreover, with the evolutionary perspective of systems theory, further inner differentiations within PS regulations, such as the creation of separate technical protocols and the establishment of meticulous procedures, can be expected to occur. The diffusive regulatory scheme might have prompted alteration, or even dismantling, of the roles of the centralized nation-state government authority in enacting regulations, and is more compatible with emerging liberalism and neoliberalism. In what follows, I will delve into how the regulatory governance shift is embodied as scientific governance, or techno-scientification in political decision making, and how the said shift has been reflected in the global restructuring of agri-food sectors captured in literature of sociology of agriculture and food production and consumption.

2.2.3 Scientific governance

As science and technology have proliferated in any aspect of modern life, whether in information technology or food production, making decisions based on scientific knowledge has become one of the chief concerns in politics governing modern society (Fujigaki 2002). This observation becomes both persuasive and ironic when we remember that it is modern technical development that, while benefitting our lives, yielded the sense of “risk society,” or fears of massive, nonetheless apparently uncontrollable, technology-induced disasters, including nuclear accident or global climate change (Beck 1992). Furthermore, the permeation of science and technology into every aspect of modern society also prompted a shift of focus in STS from “science and technology policy” to “scientific governance,” which indicates that the central national government is no longer the single authority to regulate science and technologies, and daily lives that they affect, but rather, activities of other entities, such as industry, scientific organization, consumers, lobbyists, and the market, are also to be incorporated in of science and technologies, and their consequences (Irwin 2007). This observation reflects a shift of theoretical foci parallel with what I delineated above as the governance shift in political economy during the transition from liberalism to neoliberalism.

STS scholars’ attention to the shift “from government to governance” implies that science-based political decision-making is no longer an exclusive domain of government officials and scientific experts. This recognition not only calls for a comprehensive understanding of scientific governance within a context in which diverse actors are involved and situated, but also raises critical questions as to who is involved in science-based decision making and whose interests are considered, as STS has continuously interrogated (Callon 1995). Whether from the practical concern about how better scientific knowledge can be incorporated into public decision making, or from the critical interest in assessing science’s credentials as objective knowledge, the interrelation between science and politics has become an important realm for STS scholars to proceed with their inquiries (Irwin 2007). Yet, within STS there is an admission that STS has tended to shy away from analysis of “‘mainstream’ social scientific and political discussions of such topics as globalization, socioeconomic inequality, and political economy" (Irwin 2007:599). With the growing interest within STS in how STS contributes to better understanding and promoting "public" engagement in scientific governance (Sismondo 2007), it is vital for STS scholars to address concerns invoked by globalization, such as the marginalization of rural areas in developing countries.

In STS literature on scientific governance, there are several themes that I consider relevant to my study, including boundary work (Gieryn 1999; Jasanoff 1987), co-production (Jasanoff 2004b) and networks and assemblages (Irwin 2007; Latour 1987; Latour 1993; Law 2009), and standard or grade making (Higgins and Larner 2010; Lampland and Star 2009; Tanaka and Busch 2003). For instance, boundary work, or practices demarcating science from other domains including politics, plays a critical role in constituting PS regulations as science-based regulations. In order to prevent the use of unnecessary measures that can distort free trade, the WTO Agreement on the Application of Sanitary and Phytosanitary (SPS) Measures, according to which PS measures are established and enacted, demands that protection measures be taken based on scientific evidence. Science-based analysis of phytosanitary risks, or Pest Risk Analysis, supposedly provides "objective" bases for political decision-making over whether a certain pest species is harmful or whether a particular PS treatment (e.g. disinfection of plants) is justified.

In reality, however, there are cases in which sufficient scientific evidence may not be available to determine adequate protection measures against unknown or unfamiliar pathogens. In the trade dispute case over the PS regulations surrounding apple fire blight disease between the United States and Japan (Kennedy 2000; Knight 2005), despite the “scientific evidence” presented by both countries, the case was never satisfactorily settled; interpretation and representation of the evidence were the debated issue. In the case of disputes over PS regulations between the United States and Mexico, science-based decision making might not have been neutral, but rather considered to reflect the interests of pressure groups (Ramos, Perera, and Sliter 1999; Stanford 2002). The determination of science-based regulations should not be taken as a clear-cut solution process simply because it draws upon “objective” knowledge. It is vital for my study to consider how scientific knowledge is incorporated or not incorporated in political (including, more specifically, legal and administrative) decision making over whether a certain class of insect is considered to be a harmful pest, or whether specific measures are needed to mitigate risks of a pest.

An important contribution of STS for the understanding of material politics is the insight from ANT, in particular, works on the roles of science and technology in assembling heterogeneous networks across what we know as natural and social domains, involving diverse components including people, materials, equipment, and institutions, which serve to control acts of actors at distance (Callon 1986; Latour 1987; 1993). Furthermore, in recognizing the significant roles of non-human material beings, STS scholars use the term “co-production” to see orderings in both the natural and social worlds as products of mutually constitutive creation and consolidation processes. Jasanoff (2004b) argues that “the reality of human experience emerges as the joint achievements of scientific, technical, and social enterprises . . . each underwriting the other’s existence” (17). It can be argued, therefore, that the way we experience the natural, or material, world depends on the way we know it, and vice versa; we experience the natural (material) world as a "hybrid" of its materiality and means of interpreting it.

This perspective has two relevant implications for my study. First, an epistemological and methodological implication is that, in an analysis of material politics, the "question is not whether something is political all by itself but whether it can be called as part of the process of analysing it" (Law and Mol 2008:133). I reiterate that this research constitutes the very process of co-production of sociological knowledge as to the material reality of PS regulations. Second, as Jasanoff (2004b)asserts, "co-production offers new ways of thinking about power, highlighting the often invisible role of knowledge, expertise, technical practices and material objects in in shaping, sustaining, subverting or transforming relations of authority" (4). In parallel, PS regulations as material politics are enacted through a socio-material hybrid network equipped to produce physical effects on the behaviors or movements of humans and non-humans "touched" by the authority of the regulation.

Finally, recent STS scholars have demonstrated increasing interest in diverse, rationally calculated, scientized, globally formalized, and universalized governance mechanisms, such as standards, protocols, certifications, and auditing (Higgins and Larner 2010). Indeed, modern life is rife with standardizing mechanisms that classify and categorize things (Bowker and Star 1999). Recent STS works, especially those inspired by ANT, also direct attention to the relevance of rigid materiality in the making and enacting of standards as materially embodied through a socio-technical hybrid network. A materially heterogeneous regulatory network is developed with rational-calculative, expert, and technical practices, "conducting individual's conducts" at a distance, without the conspicuous presence of a centralized authority. This image of the regulatory network engaging in diverse technical measures resonates squarely with Foucauldian governmentality in (neo)liberal political climates in modern society (Higgins and Larner 2010).

Studies of standards also investigate how standards classifying things and people can justify the inclusion of certain categories and the exclusion of others, how they engender values, norms, or moral/ethical senses, and how they relate to potential asymmetrical political and/or economic consequences among those classified. For instance, according to certain standardized classification practices, some categories such as diseases and race/ethnicity groups are classified in a particular way, and hence can be subject to exclusion from society (Bowker and Star 1999). In a similar vein, scholars in the sociology of agriculture influenced by STS have revealed that commodity standards as a means of classification, legitimated by science and technology, can not only standardize products to facilitate market circulation of products, but also classify people engaged in production into categories such as “good farmer” or “bad distributor” (Busch 2000; Tanaka and Busch 2003). While products that meet standards and individuals producing them are allowed to market their products, those that fail to meet the standards are likely to be excluded and thereby lose opportunities to gain from the market. In this sense, despite their supposed neutrality, standardizing mechanisms actually produces effects related to value formation, morality, and norms, and often results in asymmetrical economic opportunities.

2.2.4 From regulation regime to governance in globalization of agriculture and food production and consumption

In the literature of sociology of agriculture and food production and consumption, too, changes in regulatory schemes have been observed in parallel with what I called governance shift. For modern nation states, in general, securing production and distribution of food sources for their people by arranging institutions and organizations has been one of the most important roles to fulfill (Lowe, Marsden, and Whatmore 1994a). Employing terminologies of French regulation theory (Aglietta 1979; Lipietz 1987), political economists noted a particular mode of regulating agricultural production, that is, a "Fordist food regime," dominant in the 1930s through the 1940s, which enabled the provision of cheap foods through mass-scale production to feed mass-workforces to sustain a mass-production-oriented capitalist mode of accumulation in the post-World War I era (Lawrence and Vanclay 1994; Lowe, Marsden, and Whatmore 1994a). A food regime is a totality of rules or institutions that resonates with a distinctive mode of capitalist accumulation; it create commodity "complexes" consisting of chains connecting producers and consumers, states, and corporations, through which stable mass-food provision for a nation is made possible (Friedmann 1994). In a similar vein, Commodity Systems Analysis (Friedland 1984; Friedland, Barton, and Thomas 1981), an epoch making analytical frame in the sociology of agriculture, devotes a great deal of attention to the role of the state, in conjunction with labor coordination by capital and technological arrangement, in industrializing agro-food production. Thus, the mass-food provision of the Fordist food regime and/or industrialized agricultural production were tied to the development of the national economy, and coordinated labor and technology within a nation (Friedland 1991). Hence, interventions by the nation-state in, for instance, providing technical assistance for food sectors, were vital (Busch, Bonanno, and Lacy 1989); and standards established by the nation-state would also facilitate mass-scale, industrialized production and distribution of cheap foods (Lowe, Marsden, and Whatmore 1994a).

However, the instability of the U.S. economy in the 1970s (e.g., the abolishment of the gold standard) resulted in the free-flow of capital, detaching it from the national economy, leading to the demise of the Fordist food regime to be replaced by a post-Fordist regime, which sought flexible production of diverse products (Lawrence and Vanclay 1994). Consumers with diverse and individualized interests in novel and/or exotic products, along with retail sectors as mediators (or in fact creators) of such varying interests, also became significant players in regulating food provision (Flynn, Marsden, and Ward 1994). In addition, increasing public concerns about the environmental impact of the industrial mode of production came to condition agricultural production and food provision systems (Buttel 1992; Buttel, Larson, and Gillespie 1990). Thus, in the post-Fordist regime, a variety of factors influencing food provision systems came into sight, in comparison with the previous mass-production regime coordinated mainly by the nation-state government.

Meanwhile, unfettered capital departed from the national boundary, resulting in expansion of food-supply chains on a global scale, marking an era of increasing globalization of agriculture and food production and consumption. Private sectors, especially MNC and TNC, built disperse global networks of production and became decisively influential over an entire global commodity supply chain; regulations over trade also came to be discussed, negotiated, and established in international arenas such as General Agreement on Tariffs and Trade (GATT), WTO, and other regional economic partnerships (e.g., NAFTA, EC [EU]) (Heffernan and Constance 1994; McMichael 1994a). Along with the deregulation of trade restrictions and financial transactions across national borders promoting free trade, global and/or international regulatory institutions controlling agri-food trade served to benefit MNCs/TNCs from global agri-food market chains, ushering in the rearrangement or restructuring of global-scale divisions of labor (Heffernan and Constance 1994; McMichael 1994a). By exploiting the comparative advantages of different locales across the world, flexible global arrangements by MNCs/TNCs over labor, capital, and technologies came to constitute the essential mechanism of contemporary agri-food systems, which fulfilled varying consumers' needs for diverse products, such as fresh, exotic, or new products grown in developing countries for export to off-season markets in developed countries, often at the expense of the traditional subsistence farming practices of the locale (Friedland 1994a; 1994b; Raynolds, et al. 1993).

Thus, the role of the nation-state government in global-scale restructuring of agri-food systems was changing, or waning, in the shift to a post-Fordist food provision regime (e.g., Bonanno et al. 1994; Goodman and Watts 1997; Lowe, Marsden, and Whatmore 1994b; McMichael 1994b). The previous mode of regulations sustaining mass-production/consumption was strongly associated with the interest, and the central role as regulator, of the nation-state government. In the meantime, the "new" global agri-food systems enabling diversification and flexibility led to altering, or withdrawal, of the role of the nation-state government; and in turn, they gave rise to MNC/TNC's growing influence in regulating agro-food provision, and international regulatory institutions, such as GATT/WTO, which would facilitate free, autonomous, self-regulating market mechanisms in resonance with the nineteenth century's liberalism (McMichael 1994a; 1994c).

From a PS regulatory standpoint, though rarely mentioned in the literature of the sociology of agriculture and food production and consumption, the rapid increase in both the volume and the variety of traded fresh fruits and vegetables in the post-Fordist food provision system has posed many challenges. For instance, while standardized reefer (i.e., refrigerated) containers commonly used for trade of fresh produce enabled quick handling of products in volume, they also facilitated living plants and associated plant pests to survive in fresh and good condition, posing greater risks of their introduction into new habitats (Ebbels 2003). Because different plant pests demonstrate varying preferences in plants they attack, the diversification of traded plant products can demand different treatments or inspection procedures corresponding to specific combinations of pest and host plants, making statutes, manuals, or protocols of PS regulations longer and more meticulous. Importantly, in addition, despite critics' observation of its waning influences, the nation-state government still seems to be a significant actor in the enactment of PS regulations. In the rest of this chapter, and in my findings chapters, I will delve into the degree of validity regarding the argument that the role of the nation state government is waning.

Furthermore, in parallel with changes in the role of the nation-state government, the decades following the 1990s have witnessed new types of actors, procedures, or measures emerge and increase in significance in regulating primary sectors. In private economic sectors, for instance, while MNCs/TNCs maintain the capability to dominate integrated food sector complexes, actors in retail sectors are also significantly increasing in influence over production and distribution (Flynn, Marsden, and Ward 1994). Through protocols or standards for its "private" brands, retailers such as supermarkets in industrialized countries extend their reach of control over production of goods, including fresh produces, in distant locales (Busch and Bain 2004; Freidberg 2004). As alluded to in the earlier section (2.2.3 Scientific governance), certain types of regulatory mechanisms, such as standards, certifications, or auditing, have come to proliferate in agriculture, food provision, and other primary production sectors. A variety of products and production/distribution processes are now subject to different regulatory mechanisms, including organic production, quality certification (e.g., ISO 9000 series for quality management), accounting practices, Good Agricultural Practices (GAP) certification, sustainable marine and forestry resource management, fair trade, and so forth (Bacon, et al. 2008; Constance and Bonanno 1999; 2000; Eden and Bear 2010; Guthman 2004; Mutersbaugh 2005). Accordingly, organizations that establish, enact, or maintain standards, whether international, private, semi-governmental, and/or third-party, are now deemed to be vital players in regulating food provision (Bain, Deaton, and Busch 2005; Hatanaka, Bain, and Busch 2005). As suggested earlier, more recent works employing the language of ANT address fluid and dynamic processes through which consumers' interests are mobilized in food provision systems (Goodman 2002; Goodman and DuPuis 2002; Lockie and Kitto 2000). Diverse consumers' interests, whether in quality, sustainability, and justice or ethics of production, would be mobilized, channeled, and enmeshed into these new regulatory mechanisms through dynamic and complex actors' negotiations.

Thus, it is my argument that the emergence of new forms and actors for regulations reflects the shift of the regulatory scheme toward governance in neoliberal political climates where differentiated, multiple types of legitimate domination resources exist; these resources can be mobilized and assembled into a materially heterogeneous network of control. Recognizing the complex political backgrounds against which varying interests intersect, interface, or intertwine, a couple of conclusions can be derived. First, the application of scientific and technical knowledge, and related calculative, technical, and rational means, or techno-scientification, in agri-food sectors underlies these new forms of regulatory mechanisms, as well as regulatory governance in general (Higgins and Larner 2010; Higgins and Lawrence 2005b; Tanaka and Juska 2010). For instance, technical advancement in modifying chemical compositions in seeds led to creating rapeseed strains that produce edible oil, which have become standard strains and yielded standardized procedures (Tanaka and Busch 2003; Tanaka, Juska, and Busch 1999). Another conclusion, inspired with insights from STS, is that although standards or protocols communicated with "lighter" media, such as texts or diagrams, can easily cross geo-political boundaries, their enactment at the local level entails—and thus literally materializes—physical procedures and consequences, as implicated by the idea of material politics. For instance, to secure a crop of highly standardized products to meet retailers' criteria, production protocols demand fertilizers and/or pesticides to be applied in fields; to ensure uniformity of products, standardized physical settings, devices, and procedures must be installed or practiced in a packing house to ship products for export (Freidberg 2004).

Second, it is necessary to scrutinize the validity of the regulation theorist's account that would ascribe all these diverse regulation mechanisms to modes of accumulation of capital in the transition to post-Fordism. Furthermore, it might be hasty to conclude that the nation-state government has waned in, or withdrawn completely from, exerting its ability for regulating agri-food sectors. Certainly, the apparent and comparative presence of the nation-state government in regulatory activities might have shrunk, in comparison with other growing non-governmental actors engaged in regulations. Nonetheless, it does not necessarily indicate the sheer loss of capacity of the state government; but rather it suggests that ways or loci where a government operates, or objects it deals with, vary geographically, culturally, contextually, or historically. For instance, given a series of scandals in the 1990s to early 2000s that crushed consumers' trust in food safety in Japan, where historically and culturally the state has been vital in steering the entire nation, discourse in policy-making and the media revolved around the responsibilities of the national government, along with the roles of scientists in public policy-making, which, to restore trust in the food safety administration, eventually led to the founding of a new agency responsible for food safety affairs in the national government (Tanaka 2008). In addition, Marsden and his colleagues (Flynn, Marsden, and Ward 1994; Marsden, Flynn, and Ward 1994) have found that British national government agencies still played critical roles in restructuring food-related regulations and increasing involvement of retail sectors in it. As will be detailed in Chapter 5 (and suggested earlier in this section), moreover, PS regulations in general are stipulated and enacted under the responsibility of a national government as per the International Plant Protection Convention (IPPC) and SPS Agreement. These examples indicate the still robust presence and capacity of the nation-state government in certain contexts.

Therefore, given the complexity of regulatory governance, that is, the growing involvement of new regulatory actors and mechanisms, an analysis of regulations in agri-food systems should pay careful and flexible attention to how distinctive resources for legitimate and effective regulation (e.g., scientific and technical expertise, legal underpinning, or cultural resources such as trust) are assembled and optimized as a regulatory network in varying contexts and in relation to objects with which it is to function, rather than ascribing it to a particular mode of capital accumulation or to the decline of the nation-state government (Marsden 1994). It is in this analytical orientation that my approach combining ANT (which is apt to analyze processes of assembling heterogeneous resources) and systems theory (which is apt to analyze distinctive operations of heterogeneous resources), compared to a single analytical approach, will better work to examine PS regulations as material politics.

Third, as with some cases of application of standards (Bowker and Star 1999) as previously mentioned (2.2.3 Scientific governance), very importantly, diverse regulatory mechanisms yield moral and value implications, and produce asymmetrical, unequal, or paradoxical consequences among those who are involved in regulatory processes (Busch 2000; Tanaka and Busch 2003). Critics have pointed out that, in general, trade regulations as governance mechanisms of the global market-economy tend to privilege wealthy people in industrialized countries (Peine and McMichael 2005). This is more the case when exporting developing countries are trying to meet a standard, because they tend to lack technical and/or financial resources to effectively manage practices to meet standards (Bain, Deaton, and Busch 2005; Henson and Loader 2001). Despite the purported benefits from free trade promoted by "harmonized" regulations, consequences were often less than beneficial, especially in rural areas of developing countries (McMichael 2004). As with many past sociological works concerning the globalization of agriculture and food production and consumption and its relevance to development, my research is intended to shed light on the paradoxical and even potentially negative consequences of regulatory mechanisms as part of global governance in agriculture and food production and consumption.

2.2.5 Past social-science texts on PS regulations

Before concluding this chapter, I will address briefly the significance of investigating PS regulations in general. Under the trade rules stipulated by the WTO, PS regulations are a crucial component of SPS measures, and constitute an essential mechanism to facilitate transactions of agricultural products across borders. Nonetheless, although social scientists have been keen to investigate the globalization of agriculture and food production and consumption, as well as organizational and institutional changes enabling it, including global regulations and standards, (Bonanno et al. 1994; Goodman and Watts 1997; Higgins and Lawrence 2005a; Lowe, Marsden, and Whatmore 1994b; McMichael 1994b), relatively few works have dealt with PS regulations as the main focus of study (e.g., Alvarez 2001; 2006; Knight 2005; Stanford 2002). To date, a few texts in the social sciences, drawing mainly upon the political economy perspective rather than STS, have examined PS regulations and their asymmetrical impacts on rural people in Mexico. Stanford (2002) examines the quality of and PS regulations upon Mexican avocados to show the process and consequences of regulation, including technical measures, contestation from the importing country, and the resulting impact on underprivileged peasants. Echánove (2005) points out that the Mexican mango export trade does not necessarily benefit mango-producing peasants' livelihood because their limited capital impedes their ability to meet PS and other quality standards. Further, with an interest close to that of the present study, Alvarez (2001; 2006) has examined how PS regulations, including HWT and the related certification requirements of groves and packing houses, has contributed to enhancing control of production and distribution practices of mangos in Mexico. He argues that PS regulations imposed on foreign places such as rural Mexico indicate an encroachment of the nation-state border by the USDA.

The above review of critical insights of SPS measures in the enactment of regulatory institutions in the globalization of agriculture raise questions such as whose benefits are prioritized, who is making decisions to mobilize other people, and who is supposed to follow the decisions. Particularly, drawing on the political economy perspective, the works by Stanford, Echánove and Alvarez have successfully elucidated consequences of PS regulations in light of unequal class relationships in rural Mexico under the globalization of agriculture. My research intends to further the understanding of the impact of PS regulations on rural people in Mexico by scrutinizing how the shifting PS technical arrangement is changing social and material orderings.

2.3 Summary

In this chapter, I laid out the theoretical foundation to guide the research on the material politics of PS regulations. The material politics concept by Law and Mol (2008), drawing on insights from STS, ANT in particular, means to illuminate "material" processes through which rigid material beings along with more mobile “discursive” means such as statutes, combined together, draw certain distinctions (e.g., in my case, pest/non-pest), and by doing so, link distant places. Based on this theoretical framework, PS regulations can be conceptualized as a materially heterogeneous network drawing the distinction between pest/non-pest while simultaneously establishing relationships between different places (e.g., pest-free mango production site to a consumer in the United States), while also engendering values as well as moral and ethical and normative implications, and resulting in unequally distributed economic opportunities for those who are engaged in the production and export of Mexican mangos. Yet, the assembling of materially heterogeneous agents does not happen “smoothly” because of varying degrees of compatibility with each other resulting from differences in their operations, as anticipated by systems theory.

Then, I provided a review of relevant literature, including works on governance drawing on Foucault’s arguments on governmentality in conjunction with the emergence of liberalism and neoliberalism, STS on scientific governance, and the sociology of agriculture and food production and consumption on transitions between regulatory schemes in agriculture and food provision. This review established how the discussed theoretical foundation, and my inquiry into PS regulations, are situated within, and relevant to, past and ongoing literature. The recognition of the shift toward governance in liberal and neoliberal regulatory schemes where central roles of the nation-state government in regulating agri-food systems are seemingly shrinking or changing is particularly pertinent, because it indicates the relevance of my approach examining the assemblage of heterogeneous—whether human or non-human, governmental or non-governmental—agents whose legitimacy is rooted in functionally differentiated systems of modern society, such as science, law, and economics, with particular modes of operations. Therefore, the pertinence of my theoretical foundation combining ANT and systems theory lies in its aptness to capture the assemblage of differentiated functionalities to enable PS regulations entailing physical consequences through its enactment. To materialize this theoretical foundation, the next chapter will address methodologies to observe and analyze PS regulations as material politics.

Chapter 3

Methodologies

This chapter deals with how I materialize the PS regulation as material politics. I have reiterated that material politics is materialized through reflexive constructivism, meaning that politics is not severed from how I observe and write it. To keep myself as an observer conscious about this, for data collection and analysis I used qualitative, ethnographic research methods, since they require a researcher/observer to reflect on relevance of his/her position in observation. Material politics entails of course very material processes building, arranging or modifying physical beings as well. Details of operations of the PS regulation would matter. Hence, especially to address the first research question, one of better methods for me to materialize the material politics is to be on site where the PS regulation operates, to witness how those processes involving human and non-human beings draw boundaries between pest/non-pest. Yet, obviously, operations of the regulations in the past are not available for direct observation, and the current PS regulation as such is complex of technical, legal and administrative elements, without which I would not be able to understand significance of on-site operations of the regulation. Thus, I also collected document data, such as past governmental regulations, articles of journals, and so forth, as well as conducted in-depth interviews. To examine value, moral, normative implications of the PS regulation, to answer the second research question, in-depth interviews besides the participant observation, were also employed. Finally, to address the third research question asking about prospects of economic opportunities, interviews and analysis of basic statistical data on production of mangos were also collected and analyzed. All combined together, these approaches for collection and analysis were meant to trace the materially heterogeneous network of the PS regulation as a case. In what follows, I will detail rationales for adopting the case study approach and the qualitative research methods, followed by a discussion of their limitations.

This chapter explains the methods I employed to collect and analyze data about the PS regulation network as material politics. I have reiterated that material politics is concretize through reflexive constructivism, meaning that the politics of an issue are not severed from, but are rather constructed by, the observations and discourse produced by researchers, including my own writing in this dissertation. To keep myself as an observer conscious of this, for data collection and analysis I used qualitative, ethnographic research methods, since they require a researcher/observer to reflect on the relevance of his/her position in the observation. Moreover, because material politics entails, of course, material processes building, arranging or modifying physical beings as well, specific details of the operations of the PS regulation network did matter to my research. Hence, especially to address the first research question— *How does the PS regulation network operate to draw distinctions between pest/non-pest, thereby enabling the export of Mexican mangos to the United States?*—one of the better methods used to answer this question was to be physically present on sites where PS regulations operate, to witness how those processes involving human and non-human beings draw boundaries between pest/non-pest. Yet, obviously, operations of the regulations in the past were not available for direct observation, and the current PS regulations as such constitute a complex of technical, legal, and administrative elements, without which I would not be able to understand the significance of on-site operations of the regulations. Thus, I also collected documentary data, such as past governmental regulations, journal articles, and so forth, and conducted in-depth interviews. To examine the second research question— *What values are associated with the PS regulation network, and what are the normative, moral, or ethical implications of the regulations?*—I employed in-depth interviews along with participant observation. Finally, to address the third research question— *How are the PS regulations in transition in Sinaloa changing economic prospects for mango growers and packers to tap into global markets of mangos?*—interviews and analysis of statistical data on production of mangos were also collected and analyzed. Combined, these data collection and analysis approaches were meant to trace the materially heterogeneous network of PS regulations as a case for in-depth examination of them. In what follows, I will detail my rationale for adopting the case study approach and the qualitative research methods, followed by a discussion of the limitations of these approaches.

3.1 Case Study Approach

My research questions demanded sensitivity to details of processes and consequences of PS regulations which could produce a multiplicity of contextually varying meanings. Therefore this research employed a case study approach, underpinned by qualitative methods, and is strong in "contextualized comparison" or "searching for analytically equivalent phenomena…across contexts" (George and Bennett 2005:19), fitting squarely with my interests in alternative and possible orderings in multiple contexts. In general, the qualitative case-study approach can help a researcher not only learn the intrinsic characteristics of a particular case in depth, but also better understand theoretical questions, especially through verifying and modifying existing theories (Ragin and Becker 1992; Stake 2008). As Ragin and Becker emphasize delete the names in this citation following (Ragin and Becker 1992), a researcher conducing a case study has to ask, “What is it a case of?” to present a certain level of generalizability. As far as my study is *a case of* PS regulations as material politics, my study had to present plausible findings and conclusions that could persuade a reader that something similar could be observed in PS regulations in other sites. Thus, my case study, examining the network of PS regulations governing the export of mangos, more specifically, the regulatory transition in Sinaloa, aimed to present “evidence to support, contest, refine, or elaborate a theory, model or concept” (Schwandt 1997:3) with rich and detailed accounts of material politics performed by the regulations, while attempting to illuminate the globalization of agriculture as a larger background phenomenon.

As a method of inquiry, a case study focuses on a single “case.” A case as a fundamental unit of social research varies across different types of inquiries, depending on their purposes or the nature of their analytic frames, and it is crucial for a researcher to be aware that qualitative case-study research itself entails continuous and reflexive processes of demarcating a “case” (Ragin 1994; Stake 2008; Yin 1998). Accordingly, I posited that the “case” for this research refers to PS regulations as a materially heterogeneous network involving humans and non-humans that distinguishes between “pest/non-pest” (particularly, fruit fly pests) in Sinaloa and its corollaries; these regulations become embodied as politics. My data were collected within this network. This means that I tracked the historical development of PS regulations, including scientific knowledge and technologies applied in it, such as HWT and PFA, along with other control measures, as well as networks of actors currently engaged in PS practices for mangos exported from Mexico. Also, corollaries of the enacted PS regulations, such as associated values, normative and moral expectations, and varying economic opportunities were significant to the study because they signify the political implications of the regulations.

3.2 Working Hypotheses

In qualitative research where the number of studied "cases" is small, the goal of inquiry is not likely to center on true/false binary hypothesis testing, but rather to produce data for analytic induction: based on the theoretical framework, certain working hypotheses are indicated for modification or calibration according to varying, diverse, or even contradictory phenomena, such that refinement of the hypotheses with richer and thicker empirical evidence would lead to advancing the basic theoretical framework (Flick 2007; Goetz and Lecompte 1981; Lincoln and Guba 1985; Ragin 1994; Richards 2005). The material politics concept has allowed me to posit that PS regulations constitute a materially heterogeneous, evolving network, engaging human and non-human material actors with particular operations, and engendering varying orderings, including associated values, moral or normative implications, and varying prospects of economic benefits. With this theoretical framework, along with the knowledge about the PS conditions in Sinaloa outlined in Chapter 1 (Introduction), accordingly, before and during the fieldwork, I developed the following working hypotheses, which eventually constituted the primary themes in the later analysis:

- The network of PS regulations on Mexican mangos would be seen as an assemblage of not only humans but also non-humans, including both rigid material beings (e.g., devices) and lighter and flexible media (e.g., documents of statutes), as significant actors.

- § These heterogeneous actors to be assembled would demonstrate varying degrees of compatibility with each other.
- § Within the evolving PS regulation network, subcomponents (e.g., more detailed manuals) would emerge to cope with increasing complexity (i.e., uncertainty and/or variability due to new scientific findings or technical development).
- § An event within the PS regulation network (e.g., pest occurrence) could be variably and contingently attributed to different actors as responsible for it. For instance, some might attribute a pest occurrence to the government, whereas others might deem individual growers responsible for it.
- § Also, attribution of responsibility would engender associated values, norms, or moral implications. For instance, a pest occurrence might be attributed to "a lazy mango grower," "the irresponsible government," "ignorant travelers smuggling fruits," "ineffective monitoring device (e.g., trap)," or "obstinate fruit flies," and so forth.
- § Engendered values or moral implications serve as normative expectations to discipline other actors to conform to the regulations. For instance, some might argue that individual growers *should responsibly* apply required pest control measures.
- § Varying patterns of attribution of responsibility would also be related to how the regulation could be justified. For instance, consumers might be deemed responsible for a demand for quality fruits without blemish by pests, thereby used to justify PS regulations.

§ Mango growers in non-PFA areas in Sinaloa might welcome the expansion of PFA since they would be able to export fruits without relying on packers who had HWT equipment, whereas packers might see the PFA as a threat to their business.

3.3 Fieldwork in Mexico

Data with which to examine the working hypotheses were primarily collected through fieldwork in Mexico, supplemented by documentary research using electronic archives in the United States, such as LexisNexis and Hein Online. The primary data collection activity, my fieldwork, took place in the state of Sinaloa, Mexico. One of the determinant factors in the selection of the site is the political-economic backdrop of the country. Under the North American Free Trade Agreement, commonly known as NAFTA, enacted in 1994, Mexico has been advancing neoliberal policies, including the promotion of free trade. However, as revealed by debates over the promotion of free trade in the 2006 Mexican presidential election, Mexico's policy orientation has been highly contested (Bruhn and Greene 2007). This is especially true for rural areas because neoliberal policies include, for example, withdrawal of the federal programs to aid peasants via support for staple foods (Carlsen 2003; Echánove 2005). Peasants lost subsistence corn farming to cheaper U.S. corn imports and became migrant laborers as a result (McMichael 2004). Thus, during the most recent decades, Mexico has drawn the interest of social scientists who attempt to document the consequences of globalization (e.g., Hellman 1999; Myhre 1994). For this research, too, it was one of my prime concerns to examine the relevance of the neoliberal reforms to the development of PS regulations and/or consequences to the mango sector.

For the fieldwork, I chose the state of Sinaloa in north-western Mexico, facing the Pacific Ocean and Gulf of California (Figure 3-1). Chapter 4 (4.4 Research Site: The state of Sinaloa, Mexico) will provide more detailed geographic information. A few crucial factors influenced the selection of this site: Sinaloa had been a highly productive agricultural state with farming sectors eager to export products to the United States; mangos had become one of the most promising crops produced in the state, especially for export markets; and the state is in transition in terms of the status of the prevalence of fruit fly pests. Together, these factors made this state the primary site for data collection.

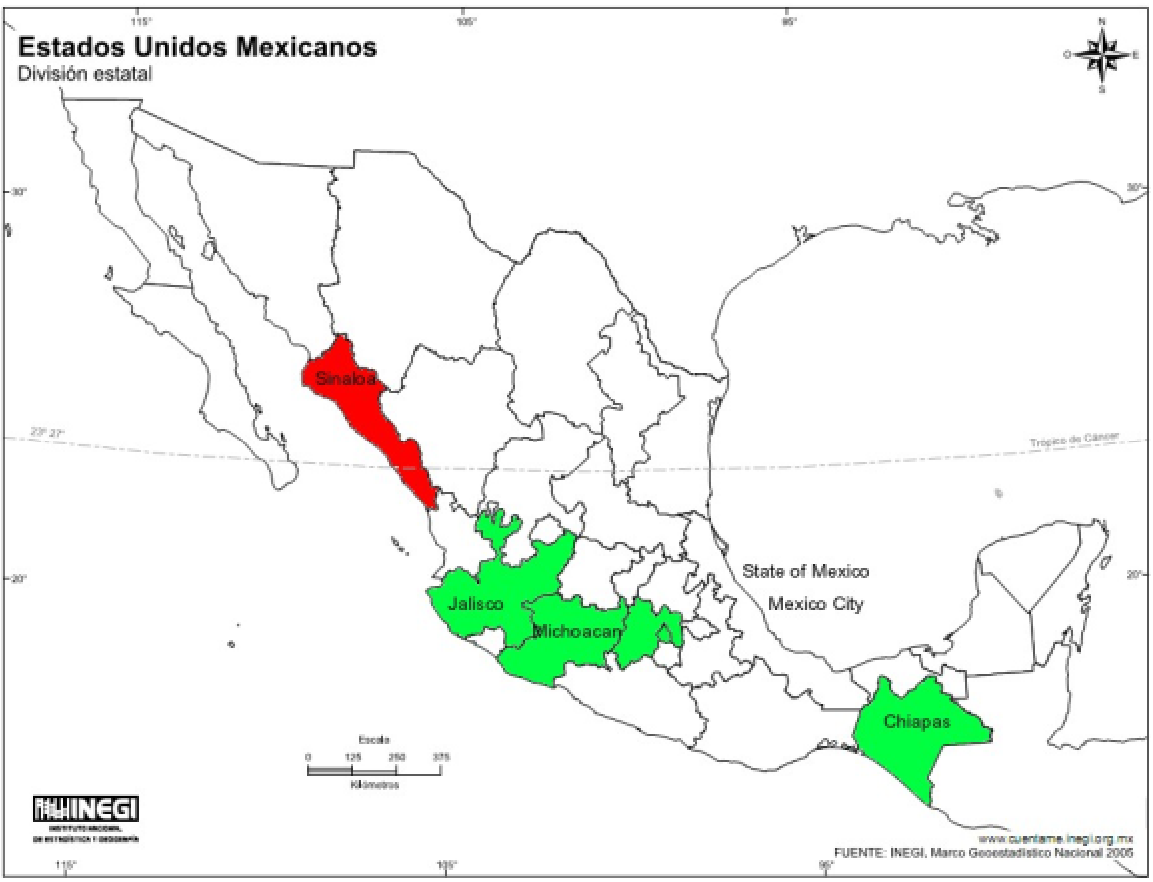

Figure 3-1 Location of the primary research site, Sinaloa (red), and other sites visited for the study
Elaboration by author based on a map image provided by Instituto Nacional de Estadística y Geografía, Mexico (INEGI)

Time spent on fieldwork totaled nine months between August to November of 2008 and February to June of 2009 in Sinaloa and in several locales in the country. I stayed in the city of Culiacán, the capital of the state of Sinaloa. The *Instituto de Investigaciones Económicas y Sociales* (Institute of Economic and Social Research, IIES) of the Universidad Autónoma de Sinaloa (Autonomous University of Sinaloa, UAS) in Culiacán provided me with facilities needed for the fieldwork, including office space, access to the Internet, and access to the university's library. From this city, I also traveled to different regions of Sinaloa (both PFA areas and non-PFA areas) as well as outside of the state. Principal sites I visited for the research are listed in Appendix 1. Important organizations engaged in PS regulations were located in Culiacán, such as a branch office of the federal agricultural department, the state government, CESAVESIN as an auxiliary organization for the agricultural ministry, and national agricultural research institutes. Some of these organizations were particularly instrumental in my document collection (e.g., governmental papers, technical journal articles, and newspaper articles) and statistical data collection.

Seeking entry points to the PS regulations network, I contacted representatives of several major organizations and groups that I considered knowledgeable about PS regulations (Appendix 1). From the representatives, I requested interviews and asked permission to conduct participant observation of their organizations' activities related to the regulations. Details of the interview method will be discussed later in this chapter. In addition, seeking potential interviewees, I attended three conferences held in Sinaloa relevant to my research topic, including (1) the 2nd International "Mega-convention" in Production Systems and Plant Health of Vegetable Production (August 20 - 23, 2008, in

Mazatlán), (2) the 7th Meeting of the Working Group on Fruit Flies of the Western Hemisphere (November 02 - 07, 2008, Mazatlán), and (3) the 7th Meeting of the Network of Socio-economics Research in Vegetable, Fruit and Flower Production (March 12 – 14, 2009, Culiacán). At these meetings I met researchers, government officials, field technicians, mango growers and packers, and requested their assistance with my study of PS regulations and the mango sector.

In most cases, the representative whom I initially contacted generously assured me that they would provide me with needed assistance or accommodation for the research, which I really appreciated. According to an interviewee, people in north-western Mexico such as Sinaloa tend to be open to guests from outside and like to treat them very generously. I agreed with his observation, as in most cases, people I contacted for the research accepted me with a very open, warm, welcoming attitude. With permission from representatives of the PS regulatory authorities, I conducted observations of PS regulatory field operations (e.g., inspections of cargo and passenger transportation at highway inspection points); the personnel kindly accommodated my research endeavor. Yet, my observations at a single site did not last more than a few days because I had to cover a variety of activities in different locales. Hence, I would not assert that I established full rapport with them, which might have given "richer" information (e.g., in-depth personal experiences or critical assessments about their jobs, etc) to make my descriptions "thicker." Still, for my research purposes, I believe, my data is rich and robust enough to meet the objectives outlined above.

Meanwhile, in some cases, I could not fully convince potential interviewees of the importance of my research project. As a couple of such individuals indicated to me, their operations concerning PS regulations were simply to, without causing major problems, abide by statutes or governmental orders ("*normas*" in Spanish); hence they could not provide me anything more than what was written in the *normas*. Although such mundaneness of regulatory operations mattered to my research, I accepted their account. Moreover, as I was interested in the quarantine inspection of plant products at entry points on the border between the United States and Mexico, I requested the permission of one of the field offices of the U.S. Customs and Border Protection of the U.S. Department of Homeland Security in Texas to observe inspection procedures. However, due to "increasing security concerns" over border control operations, my request was refused.

3.4 Qualitative Data Collection Methods

Having located entry points to the network of PS regulations, methods for the collection of data were established. Since the concept of material politics presumes varying contexts in which regulations draw "pest/non-pest" distinctions and multiple corollaries the regulations engender, my research goal was to build "thick descriptions" (Geertz 1973) of the operations of PS regulations. Accordingly, I used sensitive qualitative data collection measures to capture in detail how PS regulations were working. The methods or techniques employed to collect data included: document analysis, semi-structured and unstructured (informal, conversational) interviews, participant observation, and photographing operations of PS regulations. Collected data consisted of governmental documents, scientific/technical articles, interview memos and/or transcripts, fieldnotes that recorded observations, and photographs of events related to activities of the PS regulations.

Using multiple techniques to obtain different kinds of data is often called triangulation, which was once considered necessary to ensure the validity of data, and/or to reach "a robust fact," on the assumption that various methods corroborate with and consolidate one single "fact" (Yin 1998). However, as recent commentators emphasize, I consider triangulation to be a way to improve the overall quality of qualitative research, which could be supplemented by multi-faceted features, including credibility, trustworthiness, transferability, and diversity, richness, and/or depth of data (Denzin 1970; Flick 2007; Lincoln and Guba 1985; Richards 2005). It is this insight that underpins the usefulness of combining the following data collections methods.

3.4.1 Document analysis

To understand the historical development of PS regulations as material politics, I employed document analysis. In general, the analysis of documents as a research method is especially valuable for historical analysis since they provide stable and evidential information in an unobtrusive way (George and Bennett 2005; Latour and Woolgar [1979] 1986; Lincoln and Guba 1985; Marshall and Rossman 1999; Yin 1998). By historical analysis I do not mean to analyze exclusively "past" documents, but rather to understand the trajectory of backgrounds and discourses that brought about particular PS regulatory activities. The "stability" of a document source does not necessarily mean that a historical "fact" is immutably contained in it. Rather, meanings associated with documentary data are to be grasped in varying, situated contexts of their making and (re)reading (Latour and Woolgar [1979] 1986; Prior 2003). My research, which as such constitutes part of the context of (re)reading and making documents, enacts itself and is recursively exposed to past and future contexts.

In addition, the documentary sources were very important for my research on PS regulations because documents, including scribbled words, diagrams, or graphics to make the “natural world” visible, constitute an integral part of science (Eden and Bear 2010; Latour and Woolgar [1979] 1986; Prior 2003; Thomas 2004). Moreover, documents could illuminate how they, within themselves, “allocate and define responsibility for the acts” and have the capacity “to structure identities and bestow attributes on human subjects” (Prior 2003:94), allowing me to approach my research goals, that is, to elucidate what actors, and whose or what interests, have been deemed more influential, and how the responsibility for events is attributed to specific human and non-human actors.

My theoretical framework also informs me that the document is “material” media. In other words, the analysis of documents is situated ”to look at how the text is used by social actors in the course of their everyday activities, and how the text itself can become an agent in the various social networks in which it becomes embedded. Who recruits the report as an ally, and who is arraigned against it? What is enrolled within the report as and what is excluded? And how does the text (report) itself become an agent in a network of action?” (Prior 2003:66). For instance, I sought material that functioned as a “generative document,” which “lays down rules as to how other documents should be constructed. It contains both the conceptual structure in terms of which any explanations have to be built, and, in addition, rules for the building process” (Prior 2003:34). Technical manuals to identify, record, and report fruit fly pests are one example of a “generative document.” The significance of these documents resides in that they serve as “boundary objects” (Prior 2003; Star and Griesemer 1989), which demarcate something to include and exclude in a network, classifying acts of things and humans, making boundaries between, in my research case, pest/non-pest.

More specifically, I collected the following material. First, governmental documents were collected to illuminate how the legal and administrative underpinnings and "official" justifications of PS regulations were developed and altered. In the analysis informed with material politics, the data of this category, including written laws, other statutes, and manuals for PS regulatory activities elaborated by the governments of Mexico and the United States, as well as international organizations, were used to delineate how such "lighter" media could convey information and transcend geographical, institutional, or organizational boundaries. To collect them, besides libraries and archives of the organizations I visited for archival research (Appendix 1), governmental on-line archives (e.g. U.S. Federal Register (FR), http://www.gpoaccess.gov/cfr, Mexican Diario Oficial de Federación (DOF), http://www.gob.mx/wb/egobierno/) and commercial electronic archives such as LexisNexis and HeinOnline, served as the primary source for this category of documentary data. Second, scientific and technical articles on PS regulations to control fruit flies were identified within professional academic journals. These were valuable data sources especially to elucidate how technical aspects of PS regulations, such as control measures against fruit flies, including use of more "rigid" materials (e.g., disinfection devices), were developed, and how the research was justified. While many articles were collected through on-line databases, such as *Agricola* and *Web of Science* prior to and after the fieldwork, a substantial number of documents, especially those published before the 1990s, including technical reports of Mexican research institutes, were sought in their libraries during fieldwork. Because these older documents were not registered electronically, systematic searches for articles were conducted by checking titles and keywords through indexes and tables of contents. Third, although limited in scope and investigated only non-systematically,[3] local newspapers and documents of other key organizations, especially *Confederación de Asociaciones Agrícolas del Estado de Sinaloa* (CAADES, Confederation of Agricultural Associations of the State of Sinaloa), were sought to identify other actors, including farmers' organizations, whose acts had impacts on making PS regulations constitute a heterogeneous network. For example, newspaper articles describing mango growers' responses to governmental decisions about PS regulations were identified and analyzed to elucidate how such actors might alter the regulations. The library of *Instituto Nacional de Investigaciones Forestales, Agrícolas y Pecuarias* (INIFAP, National Institute of Forest, Agriculture and Livestock Research) in Culiacán and the Central Library of UAS were major sources of these data. Documents in paper format collected from these sources were scanned and converted to Portable Document Format (PDF) files for later analysis.

3.4.2 Semi-structured and unstructured interviews

To obtain official accounts of PS regulations as well as narratives of interviewees' personal experiences and/or opinions, I employed semi-structured interviews, combined with more informal unstructured inquiries. The semi-structured interview, being apt to elicit interviewee's viewpoints in their own words (Flick 1998), used an interview guide

[3] I expected that the Central Library of UAS and CAADES' archival storage would become the primary source for this data collection. However, it turned out that most of the UAS library's periodical collections and CAADES' documents had been destroyed by a water leak and a fire incident, respectively. As their collections were very limited and not well-classified, systematic archival research was not possible during the fieldwork.

(Appendix 2) consisting of questions on specific issues, but sought open-ended answers or narratives.

Throughout the fieldwork, I interviewed 55 key informants, including mango growers, packers/exporters, representatives of organizations such as CESAVESIN and EMEX, officials of SAGARPA and USDA-APHIS, and researchers in the natural and social sciences. Profiles of the recruited interviewees are shown in Table 3-1. The interviewees were sought and identified based on the assumption that they were knowledgeable about either specific aspects of or the entire PS regulation network or mango production and export in Mexico. In this regard, my method might entail characteristics of the “expert” or “elite” interview (Flick 1998; Marshall and Rossman 1999).

Table 3-1 Affiliations and professional categories of interviewees

Affiliation categories	Interviewees by professional categories	Number	Total
PS authorities	Management*	9	16
(including CESAVE, SAGARPA, APHIS)	Management/Grower	1	
	Inspector/Technician	6	
Farmers' organization	Management	1	9
	Management/Grower	7	
	Researcher	1	
Packers/exporters (including EMEX)	Management	5	8
	Management/Grower	3	
Research institutions	Researcher	6	9
	Inspector/Technician	3	
Workers' unions	Management	2	2
Other governmental agencies	Management	1	1
Other NGO/Third-party organizations	Management	1	2
	Inspector/Technician	1	
Independent (including retirees)	Grower	2	8
	Grower/Consultant	2	
	Management	2	
	Management/Grower	1	
	Researcher	1	
Total			55

* "Management" includes administrator, coordinator, supervisor, and leader of the organizations.

While all the interviews basically sought "expert" insights, including official accounts of how the interviewees' expertise was related to enacting PS regulations, in some interviews their personal experiences and/or opinions, which might be inconsistent with their organizations' views, were asked. I also asked questions that were not in the interview guide, but emerged as relevant themes during the course of the interview. This reflected a recent shift in the practice of interviewing to "encompass the *hows* of people's lives (the constructive work involved in producing order in everyday life) as well as the traditional *whats* (the activities of everyday life)" (Cowley, Harte, and Baker 1992:698). The underlying premise was that my interviews did not presume the "objectivity" or "neutrality" responses elicited from the interviewee. Rather, interview data were texts negotiated and co-produced (Cowley, Harte, and Baker 1992) through social processes between the interviewee and me. In essence, one of my foundational theoretical premises, that is, reflexive constructivism, reflexively applied to my research inquiry itself as social practice.

It was also crucial to clarify the measures for protection of the informants' privacy, as well as associated risks concerning their privacy and the confidentiality of their narratives. To explain this I used a consent form approved by the Institutional Review Board of the University of Kentucky, and upon the interviewee's understanding the content, obtained her/his signature on it. I taped the conversation when the informant agreed, along with writing memos (not transcripts) of the circumstances and the content of the interview either during or after the session. Based on information obtained through interviews, I also adjusted the questions to include in future interview guides. After the fieldwork I transcribed the recorded interviews and saved them as electronic files, along with additional records of the circumstances of the interviews. Levels (i.e. how verbatim) of the transcriptions varied according to the relevance to the research questions of themes discussed in the interview.

3.4.3 Participant observation

The purpose of the participant observation was to grasp how PS regulations, including mundane practices, operate on-site and how the regulations' multiple orderings involving humans and non-humans emerge through mundane practices. Participant observation allows an ethnographic researcher, through direct experiences and observation of local activities, to grasp patterns of people's acts, meanings, or beliefs in actual contexts (Fetterman 1998; Lincoln and Guba 1985). Moreover, as an essential data collection method in social sciences, qualitative observation helps this research record not only verbal and visual data, but also other information relevant to the materiality of social phenomena, such as touch, smell, and sound (Adler and Adler 1994).

It should be noted, however, that my approach to use observation as a method might diverge somewhat from a customary view on this method, often called naturalistic observation, which supposedly "occurs in the natural context of occurrence, among the actors who would naturally be participating in the interaction, and follows the natural stream of everyday life" (Adler and Adler 1994:378). Underlying this assumption is that the observation method can and should seek to increase observational efficacy and reduce the researcher's bias to secure the reliability and validity necessary to objective findings (Aluja, Arredondo, and Diaz-Fleischer 2004; Kanamori and Nakajima 2002). My methodology, on the other hand, shares more recent commentators' awareness of the difficulty or impossibility of participating in a "naturalistic setting," let alone producing “objective ethnographic truth” through observation (Aluja, Arredondo, and Diaz-Fleischer 2004). It is impossible to know how “natural” my observation was because levels of my involvement varied in the field, although in the field I was more often “observer-as-participant” and “complete observer” than “participant-as-observer” or “complete participant,” according to Gold’s typology (Gold 1958). Therefore, I was not concerned about obtaining “naturalistic settings,” and was fully aware that my data collection was based on selective, contingent observation. Moreover, I was aware that my observation might disturb ongoing “naturalistic” phenomena both by my presence and active intervention into (e.g., asking questions about) those phenomena.

My participant observations took place in diverse settings. Examples and sites of the PS activities I observed included processes of HWT, roadside inspection, pest monitoring and control activities on farms and in non-farm settings (e.g., installment and checking of insect traps, pesticide spraying, and sterile fruit fly release), and research on fruit fly biology and technical development of control measures. Given my research purposes to understand the multifaceted socio-material orderings in varying settings, and considering the resources available to me, I decided that it was more pragmatic to purposively select various settings for observation lasting one to a few days, rather than spend a longer time in a single setting. While participant observation usually necessitates a researcher’s long-term immersion in a local setting, in a qualitative study for developing, elaborating, or confirming a theory at hand, it is also important to conduct purposive, strategic selection of cases or settings, depending on the relevance of these settings (Fox 1993; Kurtz 2004).

In the sites where participant observations were conducted, I attended and observed the selected activities, and when possible, took brief memos or scribbles about what I witnessed and considered significant to the research. When necessary and appropriate, I informally asked the informants questions about the activity they engaged in. Upon returning from the observed setting, based on these field memos and my memory, I typed up detailed fieldnotes, which were stored as electronic files.

In some cases where I was allowed and/or it was appropriate in the field, I took photographs of scenes of activities, physical objects, or images related to PS regulations. The analysis of visual images of physical materials used for the regulations constitutes an important component of the present research to illuminate the material politics of the regulations. My primary purpose in using visual material was to enhance the richness of my data records and to result in an effective presentation of findings. The visual data (photographs taken with a digital camera) were stored in my storage devices (a laptop and a portable hard drive).

3.5 Approaches in Analysis

The principal procedure of the analysis of the collected data (e.g., texts and visual images) consisted of sorting and storing the data, coding (identifying and indexing relevant themes or topics), (re)categorizing and synthesizing the coded themes, writing short memos on the categorized/synthesized themes representing orderings as phenomena of material politics along with their concrete examples, and incorporating them into a narrative. To code the visual material, I added annotations of meaning to the data, and used these annotations as codes. Yet, this process comprised two major processes: descriptive analysis and theoretical analysis (Angrosino 2007). The former refers to “the process of taking the stream of data and breaking it down into its component parts; in other words, what patterns, regularities, or themes emerge from the data?" whereas the latter means "the process of figuring out how those component parts fit together; in other words, how can we explain the existence of patterns in the data, or how do we account for the perceived regularities?" (Angrosino 2007:66-67). The descriptive analysis process eventually leads to the inductive process of "generalization from and justification of a general explanation based on the accumulation of lots of particular, but similar, circumstances" (Gibbs 2007a) and to "grounded theory," or an approach of discovery of a theory from data (Glaser and Strauss 1967).

However, this research aimed primarily to prove the validity of the theory through testing the working hypotheses derived from the theory. That means that my analysis was more likely to take the latter, deductive approach, namely, theoretical analysis, which would pay attention to identifying anecdotes that fit (or would not fit) the abovementioned working hypotheses (Gibbs 2007b; Richards 2005). Nevertheless, in the fieldwork as well as during the analysis, I also left possibilities open for developing other hypotheses based on what I observed. Accordingly, the final analysis included the latter, descriptive analysis, with its more exploratory characteristics and sensitivity to what the pre-established hypotheses would be unlikely to capture, so as to notice relevant themes and accumulated, particular, similar patterns elicited from the data. Thus, the analysis in this research drew on both the inductive, data-driven approach to elicit relevant themes "up" from the data, and the deductive, hypotheses-driven approach to apply the predicted patterns "down" to the data.

Throughout the analysis, furthermore, specific attention was paid to how, in the development and enactment of PS regulations, different actors and entities were assembled and became a cohesive network capable of drawing legitimate pest/non-pest distinctions capable of enforcing legal measures to control movements or behaviors of humans and non-humans involved in or “touched” by the regulation. This analytical foci followed ANT’s dicta, “follow the actors,” and/or, “follow contestations” (Busch and Juska 1997; Tanaka and Juska 2010), which commands that the researcher trace how a specific actor (whether human or non-human, for example, a fruit fly species) moves, builds relationship with others, and is transformed, within and by the network. In other words, my analysis followed the ways relevant actors, that is, those considered responsible for an act (e.g., fruit flies are a relevant actor when they are deemed responsible for damaging fruits; consumers are an actor when they are responsible for their demands for quality fruits), were described, narrated, analyzed, discussed, and communicated in conversations, documents, or other media. The analytical command following ANT’s dicta is especially useful when the actor is involved in unstable conditions, for instance, when contestations take place over the nature of the actor (e.g., whether the fruit fly is really parasitic to a certain plant), thus revealing the multiplicity of meanings. By following the movements of the actor within network, my analysis aimed to elucidate dynamic transformations of PS regulations, extending beyond the boundaries of institutions and organizations and across space and time.

In the meantime, ANT is said to be less apt for analysis of networks in stable conditions and for explaining the failure of the extension of a network (Friedland 2001; Tanaka and Juska 2010). Although scholars employing ANT were aware that a network always entails possibilities of collapse (e.g., actor-network of scallop cultivation in France eventually collapsed (Callon 1986)), an ANT analysis “following-the-actor” is unlikely to capture the collapse of a network until it really happens. And, this inability to predict the future leads to criticizing ANT for merely retelling a known story of what has happened (Collins and Yearley 1992; Yearley 2005). Thus, considering that my research had the specific interest in mundaneness, or the (apparent) stability, of operations of PS regulations, it is reasonable to complement ANT’s dicta with an approach, or analytical attitude, put forward by Luhmann and his followers (Komatsu 2003; Luhmann 1995; Nagaoka 2006), called “unlikeliness theorem,” that is, to halt the normal presumption that what looks stable, normal, regular, or mundane, is in fact very unlikely to be stable in reality. Taking the normality as abnormal, a researcher critically asks what is behind this apparent stability, what tacit assumptions are underlying and sustaining this apparent mundaneness, where a “seed” of collapse is hidden, and so forth. Theoretically and methodologically, therefore, combining the two theoretical strands will better deal with both the historical development and spatial extension of PS regulations in dynamism, and with the regulations’ apparently stable, mundane, daily operations with critical eyes.

3.6 Limitations

However, the methodologies I chose obviously have limitations. The first limitation concerns the generalizability of findings. My case study was intended to provide in-depth delineations of PS regulations in Mexico, but not to claim that its findings are generalizable to other locales. Still, readers of a case study can recognize similarities between its findings and their experiences, and to that extent, outcomes of a case study can be deemed generalizable beyond the single case (Stake 2000; Stark and

Torrance 2005). And my study could generate findings that prompt further investigation of PS regulations as a global regulatory scheme in different places, thereby extending the generalizability. However, generalization of my findings to other cases is dependent upon future research, which will enhance relevant literature, including the sociology of globalization, of agriculture and of food production and consumption.

The second limitation is that my approach to data collection and analysis was intended to illuminate detailed and "thick" accounts of the PS regulations, but not to provide accurate quantitative estimations of the consequences of the PS regulations. For instance, my study did not enumerate how many mango growers were supporting, or opposing, PS regulations in the state of Sinaloa, or estimate with accuracy how much economic benefit the PFA could generate. This methodological drawback suggests that it is difficult for my study to offer political recommendations to immediately alter the current PS regulations. For example, quantitative data of discontented mango growers could prompt the authorities to more quickly take action, which often would necessitate quantified budgets, to improve PS programs, than qualitative descriptions of the discontent. Of course, instead, one of the strengths of my study lies in its potential to explore and identify discontent among mango growers that might be unknown to the PS authorities.

The third limitation relates to the process to recruit the informants that relied on convenient and snowball sampling strategy, rather than a systematic selection. More specifically, the interviews and participant observation with the key informants, who were knowledgeable about the regulations, might be "biased" toward expert or elite perspectives. The information obtained from them was by no means representing all the people involved in the regulations. However, elite interviewees can include not only economically affluent people, but also those at higher positions in an organization regardless of economic status (Rubin and Rubin 1995), and have distinctive advantages, such as access to expert knowledge and to further data sources or research opportunities (Moyser 2006). I benefitted from interviewing several key interviewees, including senior officials of the PS regulatory authorities. Still, it is difficult to have a long interview with busy elite informants, and hence difficult to develop rapport with them (Rubin and Rubin 1995). Accordingly, it was challenging for me to obtain detailed stories, including personal views or experiences, beyond "official" accounts of PS regulations, from some of the interviewed representatives of organizations.

The fourth and last limitation is related to the concept of "ordering." In Chapter 2, I made the case that the concept was to capture the effect of the PS regulations as an ever incomplete and temporal outcome rather than as a static status. Yet, my delineations of the regulations *as writings* remain to be only static forever. Nonetheless, I insist that the concept of ordering still has an important implication that my observations and interpretations of the consequence of the PS regulations will always be open to (re)interpretations, including criticisms, thereby remain incomplete. It is in this sense that the outcome of the PS regulations should be grasped as an ordering.

3.7 Summary

The present research drew on the case study approach, consisting of qualitative data collection and analysis methods. This strategy was premised on the aptness and sensitivity of the employed methods to generate rich and "thick" descriptions of the operations of PS regulations, allowing me to understand the performance of rigid non-human material beings in the regulation and multiplicity of meanings and contexts the regulations engender, which the material politics concept envisages. For data collection, more specifically, participant observation, semi-structured interviews, and documentary analysis were employed in the nine-month fieldwork in Mexico; for the analysis, both the data-driven, inductive, descriptive analysis, and the hypothesis-driven, deductive, theoretical analysis were combined and applied, so that while examining the validity of several working hypotheses derived from the theoretical foundations, the analysis could also explore other relevant themes. A few dicta suggested by ANT and systems theory, "follow the actor," "follow contestations," and the "unlikeliness theorem," provided analytical guidelines to elucidate processes through which PS regulations develop a heterogeneous network as well as what might be concealed and made latent in such dynamic assembling processes.

However, there are a few limitations in the research methodology adopted for this study, including the inability to provide broadly generalizable findings, the inability to provide a quantified estimation of the consequences of PS regulations, possible biases towards "elite" perspectives, and the writing that can grasp the ordering of the regulations only as static fix. Despite such methodological limitations, I believe the data and its analysis in the following chapters robustly and vividly delineate the material politics of PS regulations as a global regulation materially enacted at the very local level. Prior to demonstrating outcomes of the analysis based on the approaches outlined here, the next chapter, Chapter 4, will provide more detailed descriptions of major actors, such as fruit flies, mangos, PS regulations, and the site of the research, the state of Sinaloa.

Chapter 4

Introducing Actors, Setting the Scene

This chapter will delineate the setting of the research and the "actors" as the main "cast" involved in it, including the legal framework of PS regulations, *Tephritidae* fruit flies, mangos, and the principal research site, the state of Sinaloa, Mexico. An "actor" in this study refers to any entity, whether human or not, to which an event that happens within the PS regulation network is attributed as an act. This study explores a variety of actors involved in the PS regulation network, including not only Mexican mangos, but also other fruit crops, places, devices, and people that make it possible to draw distinctions between pest/non-pest as to fruit flies. In what follows, I will first provide an overview of PS regulations with an emphasis on their legal and organizational framework, followed by presentations of the major actors such as *Tephritidae* fruit flies and mangos. The chapter will conclude with an introduction of the principal research site, Sinaloa, as the scene where these actors are in play.

4.1 Legal and Organizational Framework of PS Regulations

Law and Mol (2008) state that "while material politics may well involve words, it is not discursive in kind" (141). Material politics is not entirely discursive[4]—in the sense of verbal or textual communication and argumentation politics—but it is always embodied and co-produced with non-verbal material (Jasanoff 2004a). Scientific knowledge, which would tend to be more textual or reliant on verbal communication or

[4] The words *discursive* and *discourse* have a variety of connotations, which even appear contradictory. Webster's New Collegiate Dictionary (9th ed.) lists, as meanings of *discursive*, "moving from topic to topic without order: rambling," "proceeding coherently from topic to topic," and "marked by analytical reasoning." Meanings of d*iscourse* (as a noun) include, "capacity of orderly thought," "verbal interchange of ideas," "connected speech or writing," and "social familiarity."

argumentation, and technology which engages less verbal beings in control over nature, are not separable (David 2005). In this study, laws and related organizations are analyzed as being constituted by science and technical practices. Laws, co-produced with science and technology, are critical because they endorse the legitimacy of many modern key institutions (Jasanoff 1995; 2007). The legal systems and organizations that enact PS regulations are hierarchically structured (Table 4-1). The SPS Agreement directs that trade regulations must be “harmonized” by standards such as the International Plant Protection Convention (IPPC) and International Standards for Phytosanitary Measures (ISPM) by the IPPC Secretary, an affiliation of the Food and Agriculture Organization (FAO), in order to reduce unnecessary barriers distorting free trade (Kennedy 2000). IPPC guides “harmonization” in the area of PS regulations. It convenes negotiations by government delegates to establish the technical and legal specifics of International Standards for Phytosanitary Measures (ISPMs). IPPC also stipulates that Regional Plant Protection Organizations (RPPO) be formed to coordinate PS activities in specific geographic regions. In the North American region, Canada, the United States, and Mexico constitute the North American Plant Protection Organization (NAPPO), which has its own regional rules.

Under the international legal and organizational framework, each country establishes a National Plant Protection Organization (NPPO) in charge of domestic PS regulations (e.g. APHIS in USDA) and its own PS law in line with the IPPC (e.g. U.S. Plant Protection Act, Mexican *Ley Federal de Sanidad Vegetal*). For example, according to the domestic PS law, APHIS officials inspect mangos imported from Mexico at the U.S. border. Within the national framework, local (state or municipal) governments establish their own statutes and affiliated organizations. In each state of Mexico, *Comités Estatales de Sanidad Vegetal* (CESAVE, State Phytosanitary Committees) and *Juntas Locales de Sanidad Vegetal* (JLSV, Local Phytosanitary Boards) are organizations stipulated by the Mexican PS law. Personnel of these local governments and organizations undertake local-level PS regulatory activities, such as pest monitoring.

Table 4-1 Legal and Organizational framework of PS regulations

Organizations	Examples of Statutes	Examples of Activities
International level		
· FAO · IPPC	· SPS Agreement · IPPC Text · ISPMs	· Negotiation for establishment of international technical standards · Information clearinghouse (reporting, collecting, and sharing) of pest occurrence
Regional level		
· RPPO	· NAPPO Regional Standards for Phytosanitary Measures on Establishment of Fruit Fly Pest Free Areas in North America	· Negotiation for establishment of Regional Standards · Information clearinghouse at regional level
National level		
· SAGARPA · USDA APHIS	· PS laws (Mexico *Ley Federal de Sanidad Vegatal*) (U.S. Plant Protection Act) · Mexican NOM and U.S. CFR · Work Plan for the Mexican Mango Treatment and Preclearance Program	· Mexico national fruit fly eradication campaign & establishment of PFA · U.S. border import inspection · Monitoring at packing/disinfection facilities · Bi-lateral negotiation to establish PS regulations
Local level		
· State and municipal governments · JLSV	· Area specific statutes	· Monitoring such as roadside inspection

Locally practiced PS measures on Mexican mangos are enacted also as legal practices from within the global structure, which engages and is enacted by diverse actors, from government delegates in an international negotiation, to local inspectors in roadside inspection, from fruit flies to hot water and pest traps. However, as Jasanoff (1995; 2007) points out, and in resonance with functional differentiations suggested by systems theory, while they are mutually constitutive practices co-producing knowledge, there are also distinctive and competing "cultural" differences between law and science. Establishing and enacting PS regulations as legal statutes whose viability and authority is endorsed by scientific and technical knowledge may entail conflicting negotiations through which new orderings will emerge. Such negotiations appear in different forms through the transition occurring in Sinaloa between technical and legal arrangements of PS regulations on fruit flies; new statutes and technologies are being enacted.

4.2 Tephritidae Fruit Flies

4.2.1 Biology of fruit fly pests

Tephritidae is one of the families constituting the *Diptera* order, which includes species commonly known as flies.[5] *Tephritidae* flies, consisting of approximately 4500 species, have an extraordinary capacity to adapt to different environments and climate conditions, and are an important agricultural pest that attacks practically all fruit crops across the world (Aluja [1993] 1994; Carroll et al. 2002 onwards). Among more than 480 genera under the *Tephritidae* family, of particular economic importance and necessary to quarantine are *Anastrepha*, *Rhagoletis*, *Bactrocera* (formerly grouped as *Dacus*), and *Toxotrypana* and *Ceratitis* (Aluja [1993] 1994; Weems et al. 2004). Approximately 250

[5] Under the *Diptera* order, there is another family called *Drosophilidae.* This family includes the *Drosphila* genus to which some species that are also called fruit flies belong. One of the most known species of this genus is *D. melanogaster*, which is used as a model organism for biological research. Although some of the species of *Drosphila* are known to have attacked fruit crops (Vancouver Sun 2010), its economic significance is limited compared to that of *Tephritidae* species.

Tephritidae species are considered pests (Carroll et al. 2002 onwards; White and Elson-Harris 1992).

Adult *Tephritidae* fruit flies have bodies of yellow, orange, coffee, black or combinations of these colors. They are 0.12 to 0.4 inches (3 -10 mm) in length and 0.05 to 0.13 inches (1.25 to 3.25 mm) in diameter. A pair of wings attached to the thorax allow an adult to fly more than 200 km with wind.[6] An adult female fly can oviposit up to 12 times in a few hours and each time lays 1 - 12 eggs with its long ovipositor in a fruit. Though there are variations among species, some adult flies can survive for 8 to 12 months. Adult flies feed on the secretions of plants, birds, or other insects such as aphids, which supposedly provide the protein sources needed for reproductive maturation. Entomologists assume that bacteria on plant surfaces play significant roles as protein providers for fruit flies, suggesting the existence of a symbiotic relationship between the two organisms. Attractant substances used for fly traps, emitting fume of protein sources, lure flies. Female adults, those inhabiting tropical areas in particular, can lay more than 1000 eggs in a single life (e.g., a female Mexican fruit fly, *Anastrepha ludens,* lays 40 eggs at a time, 100 or more a day, and about 2,000 over her life span (Weems, et al. 2004)). Eggs laid in a fruit have an elongated form and are less than 2 mm. Larvae (maggots) are white or yellowish white and vary in length from 0.12 to 0.14 inches (3 to 3.5 mm) depending on the species. Though varying among species, larvae spend a time period of a week to a month in the fruit, passing three stages (instars), feeding on fruit pulp, and causing damage to fruits. Mature third-instar larvae transform into pupae in the soil. While larvae of some species "jump" from the fruit on the tree to the ground, others

[6] The family name *Diptera* means "two wings."

(e.g., *Anastrepha* spp - principal pest fruit fly species in Mexico) escape from the fruit after it has dropped on the ground. The pupae stage for “multivoltine” species (i.e., those having various generations in a single year), such as *Anastrepha spp*., takes a week to a month until emergence, while pupae of “univoltine” species, such as *Rhagoletis pomonella* (Apple maggot, found in the United States), spend a winter before emergence. Thus, in order to control the major fruit fly species in Mexico, such as Mexican fruit fly (*A. ludens*), it is critical to dispose host fruits by burying them deep in the ground in a timely manner so that mature larvae cannot escape.

4.2.2 The “fruit fly problem”

The “fruit fly problem” includes “direct” and “indirect” economic damage by the pest (White and Elson-Harris 1992). The “direct” damage by the fruit fly pest is caused by its larvae feeding on fruit pulp, destroying the crop’s value. *Tephritidae* pests also cause “indirect” economic damage. As they have an ingenious capability to adapt to varying environments and utilize diverse host plants, they can become devastating pests in places far away from their native areas. Given the fear of the pest’s destructive potential, plant protection authorities (e.g., USDA-APHIS) apply stringent quarantine measures, whether domestically or internationally, against these species. Such regulations can either trample a potential export market for a producing country or force the producer to apply additional costly disinfection measures, such as heat treatment.

Exact estimates of economic damage by fruit flies, especially potential losses by “indirect” damage, are difficult to calculate and rarely available (Allwood and Leblanc 1997). Yet, taking Australia’s fruit production in the 1980s as a case, under the presumption that no control was taken, a potential loss of 100 million Australian dollars out of the total production of A$850 million was estimated to be due to fruit flies (FAO-RAPA 1986; White and Elson-Harris 1992). Also, in Okinawa, a prefecture in the southwestern archipelago of Japan, *Bactrocera cucurbitae* (melon fly), a vicious pest to melon crops, was completely eradicated in 1993. This allowed the shipment of bitter melon, a vegetable that has become very popular in recent decades, to the mainland Japan, providing 400 million yens annually (4 million U.S. dollars) to the prefecture, which was a hidden economic loss caused by the fruit fly (Okinawa Prefecture 2008).

4.2.3 Tephritidae in Mexico

Ceratitis capitata (Mediterranean fruit fly) is native to Africa and has spread to almost all tropical and temperate areas of the world. Being from Africa, it is an "exotic" pest to America. There are more than 200 recorded host species for *C. capitata*, which is considered one of the worst agricultural pests. *Anastrepha* species are endemic to American tropical and sub-tropical zones, extending from the southwestern US (Texas, California, and Florida) through northern Argentine and Chile, and to the Caribbean islands. The *Anastrepha* entails approximately 200 species, being the largest genus in the Neotropic zone (Aluja [1993] 1994). Both *Anastrepha* pest species and *C. capitata* are "polyphagous," which means they attack plants belonging to different plant families (rather than genera). This disposition makes these species more flexible and adaptable to different environments, thereby highly detrimental to agriculture and thus subject to stringent quarantine regulations. The range of hosts (i.e., plants on which pests feed) for the entire *Anastrepha* genus is very broad with a record of 270 plant species in 41 families, although in fact the majority of the species attack only a relatively limited number of plant species (Norrbom 2000). Certain species within *Anastrepha*, especially those in the *fraterculus* group, including those mentioned above, are “generalists” (i.e., less selective in plants to feed on) and thus possess detrimental potential as agricultural pests (Norrbom 2000).

According to Hernández-Ortiz (2007), 37 *Anastrepha* species are known to exist in Mexico. Although the information is slightly older, Ireta and Guzmán (2002) note that eight fruit fly species are known to utilize the mango as a preferred and/or alternative (i.e., used when the principal preferred host is unavailable) host. Out of the eight species, seven are known to exist in Sinaloa among which two species, *A. obliqua* and *A. ludens*, are considered more economically important because of their prevalence, geographic distribution, and numbers of possible host plants (Huerta Paniagua, et al. 1986; Ireta and Guzmán E 2002). As I will discuss in Chapter 5, however, it is not a simple, taken-for-granted task to determine a fruit fly pest vis-à-vis a host plant because the relationship between a “pest” and a “host” plant is contingent, reflecting the complex nature of ecological and socio-economic interactions involving plants, insects, and humans.

4.2.4 Essentials of controlling Tephritidae fruit fly pests

Given the ecology and physiology of *Tephritidae* pests and their relationship with human beings, Aluja ([1993] 1994) argues that collective and coordinated applications of various pest control measures are essential to achieve the integrated pest management (IPM) of fruit flies. While there can be different definitions, IPM generally refers to a system, or a set of diverse practices, that maintains the population of pests below the level that causes economically unacceptable damages to a crop while minimizing adverse impacts on society and the environment; IPM practices should be based on the understanding of the agro-ecology in which the crop and the pest are found (Aluja [1993]

1994; Norris, Caswell-Chen, and Kogan 2003). Hence, to control[7] *Tephritidae* pests, a variety of measures are applied, from detection by sampling of host plants and trapping, chemical control, mechanical-cultural control, biological control, sterile insect technique, and legal measures. Essentials of these control measures will be provided below. Chapter 7 will lay out detailed accounts of their applications in Mexico and the state of Sinaloa.

Because IPM of *Tephritidae* pests should be based on accurate knowledge of the pest's existence and density, "detection of the pest" is a critically important element. This is usually done by using different types of traps (Figure 4-1). Throughout a geographic area with a certain density, traps containing substances (e.g., hydrolyzed protein, insect pheromone, etc) that lure fruit flies are installed and inspected regularly to see if target species are captured. Growing healthy and vigorous crop plants is a key for successful implementation of IPM. Thus, along with soil, fertilization, plant nutrition control, and plant density management, "mechanical-cultural[8] control," including weed management to eliminate refuges for the pest and elimination of infested crops, is an important element of *Tephritidae* pest control. Many mechanical-cultural measures are feasible for resource-poor growers. Meanwhile, "chemical control," or application of pesticides, is also a common practice for *Tephritidae* control. This category includes not only spraying pesticides in orchards, but also fumigation of harvested fruits. However, given growing

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[7] White and Elson-Harris (2002), following Bateman (1982), make a distinction between *control* and *suppression*: the former refers to applying measures to protect a single orchard while the latter means measures covering a large area. However, in my study I will use the term "control" for measures to prevent damages by a pest for in a single farm and a certain geographic area beyond the farm, whereas I use "suppression" to refer to procedures designed to reduce the population density of pests in the field.

[8] This "cultural" means "of cultivation" rather than ways of life or values of a specific group or country.

concerns about the environmental impact of pesticides, “biological control” is also an important element of *Tephritidae* control. Included in this category are applications of natural enemies such as predators, competitors, parasites, or parasitoids in order to suppress a pest population in the field. “Sterile insect technique (SIT),” a more widely applied practice in fruit fly control than in any other pest species, is a “birth control” technique aiming to suppress, or eradicate, a wild pest insect population by rearing and releasing a massive number of sterile male insects to fields where they mate with females, which will lay only infertile eggs. Continuous release will deprive the wild insect population of the chance of reproduction, thereby eventually suppressing the wild pest population.

Figure 4-1 Traps used for detection of fruit flies in a research laboratory of a University in Tapachula, Chiapas, Mexico
(Photo by author)

“Post-harvest quarantine treatments” are also widely used in crops susceptible to infestation by fruit fly pests, and thus are a distinctive element of *Tephritidae* control. HWT, hot-air or vapor treatment, cold-treatment, use of fumigants such as ethylene dibromide (EDB) and methyl bromide (MB), and use of irradiation are included in this category of control measures, which allow fruits grown in an area infested with the pest to be exported to other areas. An alternative to post-harvest treatments to make products eligible for export or shipment from a pest-infested area is to establish “PFA,” defined by IPPC as “an area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained” (IPPC 2007). In the state of Sinaloa, my primary research site, the regulatory technical scheme for exportation of mango fruits is in transition from post-harvest treatment (HWT) to PFA. These technical schemes will be discussed later in this chapter and in more detail in Chapter 6 and 7.

Finally, “legal controls” include a variety of regulatory actions legally endorsed or made mandatory, such as quarantine, certification for movement (transportation) of fruits, certification of origin and disinfection treatment, record of pest control measures, inspection of cargo at (air)ports and highways, and so forth. As described above, the hierarchical legal structure from the international to local levels governs specific actions for controls. These measures allow for control beyond venues of production and distribution of the commodity. Given that *Tephritidae* pests are highly mobile and adaptive to diverse environments including non-farming sites, it is crucial for the control to be able to enforce its effects beyond venues of production and distribution of the commodity.

4.3 Mango

4.3.1 Description of the crop and its origin

The mango (*Mangifera indica L.*) is an important global agricultural commodity that generates substantial export revenues to the producing countries (Jacobi, MacRae, and Hetherington 2001). It belongs to the *Anacardiacecae* family, which includes the cashew, the pistachio, the Japanese varnish (lacquer or urushi) tree, poison ivy, and poison oak. While the mango is perhaps the most economically important crop in *Anacardiacecae* (Rieger 2006), many plants in this family, including mango, produce sap containing a toxic substance, called urushiol, which causes human allergic reactions, such as rashes, and prevents some people from consuming the fruits.

The mango is a large tree growing up to 100 feet and lives more than 100 years (Figure 4-2). Once or twice a year, or sporadically throughout the canopy, leaves flush and turn from a reddish color to dark green. The leaf is lanceolate (i.e. lance-shaped) of 4 to 16 inches long and 1 to 2 inches wide and may survive for several years. Its terminal panicles bear tiny (one-eighth to a quarter inch) yellowish flowers (Figure 4-3).[9] Only one or a few fruits grow in a panicle (Figure 4-4). Temperatures or seasonal dry conditions trigger the formation of flower buds, although there are variations in the demand for such climatic conditions among cultivars. Lack of conditions that induce reproductive growth can result in biennial production, which is problematic for commercial growers. To obtain a uniform formation of flower buds and sets of fruits, growth regulators, such as potassium nitrate (KNO_3), naphthalene acetic acid, and Ethephone are often applied.

[9] A panicle is a type of cluster of flowers and fruits. A "terminal" panicle means a panicle formed at the end, or top, of a branch.

Figure 4-2 Old mango tree in Tapachula city, Chiapas, Mexico (Photo by author)

Figure 4-3 Flowers (panicles) of mango in El Rosario, Sinaloa, Mexico (Photo by author)

Figure 4-4 Mangos awaiting harvest in Escuinapa, Sinaloa, Mexico (Photo by author)

Mangos originate from south of Asia, more specifically, the “Indo-Burma” region, including today’s Myanmar, Bangladesh, and northeast India, where the crop has been cultivated for over 4000 years (Indian Council of Agricultural Research 1967; Ireta and Guzmán E 2002; Nakasone and Paull 1998; Rieger 2006). Mango was introduced to Southeast Asia during the fourth and fifth centuries and to the Philippines in the fifteenth century, probably by Indian traders or Buddhist monks. The crop was transported by the Portuguese to East Africa and Brazil, and by the Spanish from the Philippines to Mexico by the eighteenth century; and during the early nineteenth century by Spanish traders from Mexico to Hawaii (Nakasone and Paull 1998)[10].

[10] Ramírez Villapudua et al. (2006) note that the mango was introduced to the Americas (Mexico and Brazil) even earlier than sixteenth century.

4.3.2 Worldwide production and trade of mangos

In 2008, the total mango production in the world reached nearly 35 million metric tons within 4.8 million hectares, with India, China, Thailand, Mexico, Indonesia, Pakistan, Brazil, and the Philippines being major countries producing fruits (Table 4-2). Despite their significant status as a globally traded agro-commodity, most mangos are consumed in countries in which they are produced. In 2008, less than 1.2 million out of the world total mango production of 35 million tons was destined for export (Table 4-3). This relatively limited export is, first, because mangos are highly perishable and susceptible to cold storage, and second, because they are a host to detrimental fruit flies, for which many importing countries require quarantine treatments, such as heat treatment, which can damage the fruit's quality (Gutierrez et al. 1999; Ponce de Leon et al. 1996; Leon et al. 1999; Yahia et al. 1999; Yahia et al. 1999; Yahia and Pedro-Campos 1999). This is why post-harvest PS treatments for disinfection and quality preservation are crucial for this commodity (Jacobi, MacRae, and Hetherington 2001).

Table 4-2 Major mango-producing countries in the world (quantity 1000 tons)

Country\Year	***1978***	***1988***	***1998***	***2008***
India	7,527.2	7,927.0	10,230.0	13,649.4
China	246.7	627.5	2,561.5	3,976.7
Thailand	580.0	840.0	1,087.8	2,374.2
Indonesia	164.0	532.0	600.1	2,013.1
Mexico	540.7	1,091.0	1,473.9	1,855.4
Pakistan	561.1	712.8	916.8	1,753.7
Brazil	709.0	543.7	468.6	1,154.7
Philippines	335.2	361.1	945.2	884.0
Bangladesh	254.8	160.2	186.8	802.8
Nigeria	350.0	400.0	731.0	750.0
Other countries	1,924.3	2,527.8	3,556.3	5,778.7
World Total	13,195.0	15,725.0	22,759.8	34,994.6

Source: FAOSTATS (http://faostat.fao.org/)

Table 4-3 Major mango-exporting countries (quantity in tons)

Country\Year	***1978***	***1988***	***1998***	***2008***
India	3,710	16,876	47,149	274,854
Mexico	16,740	14,799	209,426	226,083
Brazil	45	5,303	39,186	133,944
Netherlands*	330	2,630	17,154	94,646
Peru	-	2,503	10,541	82,696
Pakistan	1,203	11,003	40,251	69,324
Thailand	-	6,713	10,209	61,608
Ecuador	-	44	10,021	34,615
Philippines	9,034	13,591	52,579	20,541
Guatemala	-	-	10,195	20,315
Other Countries	11,664	32,306	92,740	176,025
World Total	42,726	105,768	539,451	1,194,651

Source: FAOSTATS (http://faostat.fao.org/)
* Netherlands does not produce the fruit but only trades as a major entry port to other European countries.

4.3.3 Mango production and consumption in Mexico

Mexico is one of the major mango-producing countries and was the world's largest mango-exporting country until 2004 (FAOSTATS http://faostat.fao.org/). The country has a long history of growing, consuming, and exporting this tropical fruit, although it is a non-native plant. As mentioned earlier, mango was first introduced to Mexico in the late eighteenth century through a Pacific port of Acapulco from the Philippines, followed by another wave of introduction through the Mexican Gulf to Veracruz in the early nineteenth century (Ireta and Guzmán 2002).

The variety first introduced to the country is called Manila derived from the capital of the Philippines. Unlike the Manila, the cultivars introduced to Veracruz were monoembryonic, meaning that a seed contains only one embryo. In polyembryonic varieties, a seed contains several clonal embryos, originating from maternal somatic cells, along with a zygotic (i.e., hybridized with a male zygote from a pollen) embryo.[11] Such genetically-identical embryos tend to be more rigorous than hybrids, suppressing the latter's growth, resulting in the difficulty of cross-breeding for genetic improvements (Nakasone and Paull 1998). In mango varieties, Indian types, characterized by more round and plump fruits, with bright red blush skin, exhibit the polyembrionic disposition, whereas Indo-China types, including the Manila, are characterized with flattened, kidney-shaped, elongated fruits with light green or yellow skin (Rieger 2006). Cross-breeding of a polyembryonic cultivar is possible by using a monoembryonic cultivar as the female parent (but not vice-versa).

[11] Polyembryonic seeds are found in other fruit crops (e.g., citrus) as well and demonstrate dispositions similar to those explained here.

Because monoembryonic cultivars generate hybrids more easily than polyembryonic types, mangos introduced in the second wave were multiplied through seeds, repeating cross-breeding, resulting in a large variation of genetic strains, which are now often called *criollos*.[12] Usually, a *criollo* does not refer to an established commercial variety but means a strain of plants that have survived native conditions and/or human selection since its introduction. Characteristics and qualities of *criollo* fruits demonstrate considerable variation.

A more significant event for the commercial production of Mexican mangos was the introduction during the 1960s of several major commercial varieties from Florida, in the United States, through the state of Guerrero. These varieties bred and/or selected in Florida, known as Florida cultivars, such as Haden, Irwin, Keitt, Kent, and Tommy Atkins, possessed characteristics suitable for commercialization—higher productivity, tolerance to handling and shipping, and a pleasing external appearance—and thus have become varieties of economic importance for Mexico, as well as many other mango-producing countries[13] (Campbell and Zill 2006; Ireta and Guzmán 2002). In addition to

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[12] In general, "*criollo*" means a native and/or descendant of immigrants, especially to Latin America, although the word has many different connotations.

[13] With the increased effort to breed mango cultivars since the late eighteenth century, Florida was once recognized as the "second center of genetic diversity of mango" (Ojeda and Estrada 2002: 9-10) following the original genetic center being India as mentioned. The USDA collected genetic materials from across the world and used them for improvement of the plant. One of the most successful results of the breeding efforts in Florida was the discovery of the cultivar Haden, which maintained the status as the most important mango variety in Florida for more than forty years (Ojeda and Estrada 2002). However, along with urbanization in production areas and hurricanes that struck Florida, the increase in import mangos from Mexico and Tropical America promoted by trade liberalization (and recent lifting of import bans on mangos from a few Asian countries will further push this trend) led the commercial production of mango fruits in Florida and the US to vanish almost completely (Campbell and Zill 2006; Rieger 2006).

the Florida cultivars, there is another economically important and original variety from Mexico, Ataulfo. This cultivar, originally discovered and selected from mango trees in the Chiapas state, has been officially recognized by the Mexican government as a regionally specific product of the state (*Denominación de Origen*).[14] As with the Tequila liquor, another official regional-specific product of Mexico, the Ataulfo has to be grown under specific conditions of the producing region in order to be marketed as “Ataulfo.”

In Mexico, over 97 % of the mango production is concentrated in 10 states, including Sinaloa, as shown in Figure 4-5(PROSERCO 2007). According to *Promotora de Servicios Comerciales Del Estado de Campeche* (PROSERCO), Mexican mango producers are classified more or less in two groups: “integrated” growers who have the capacity to sort and pack fruits, and small-scale growers who rely on commercialization through selling fruits to integrated growers and intermediaries (Figure 4-6) (PROSERCO 2007). Packers who also undertake disinfection, as explained later, play important roles in the domestic and international distribution of Mexican mangos. Meanwhile, small-scale mango growers, or peasants, who tend to lack technical and financial resources, in many cases have to rely on packers/exporters or intermediaries (often called “*coyotes*”) for marketing their fruits. Their lack of resources puts peasants in a weak or vulnerable position in negotiations with buyers over prices or conditions to sell their products.

[14] It is believed that the Ataulfo cultivar was discovered from mango trees in the city of Soconusco, Tapachula of the state of Chiapas. Although its progenitor has not been completely determined, some argue that it originated from a criollo or a plant derived from the Indian Alphonso variety (Ireta and Guzmán 2002).

Figure 4-5 Major mango-producing States in Mexico Elaboration by author based on PROSERCO (2007)

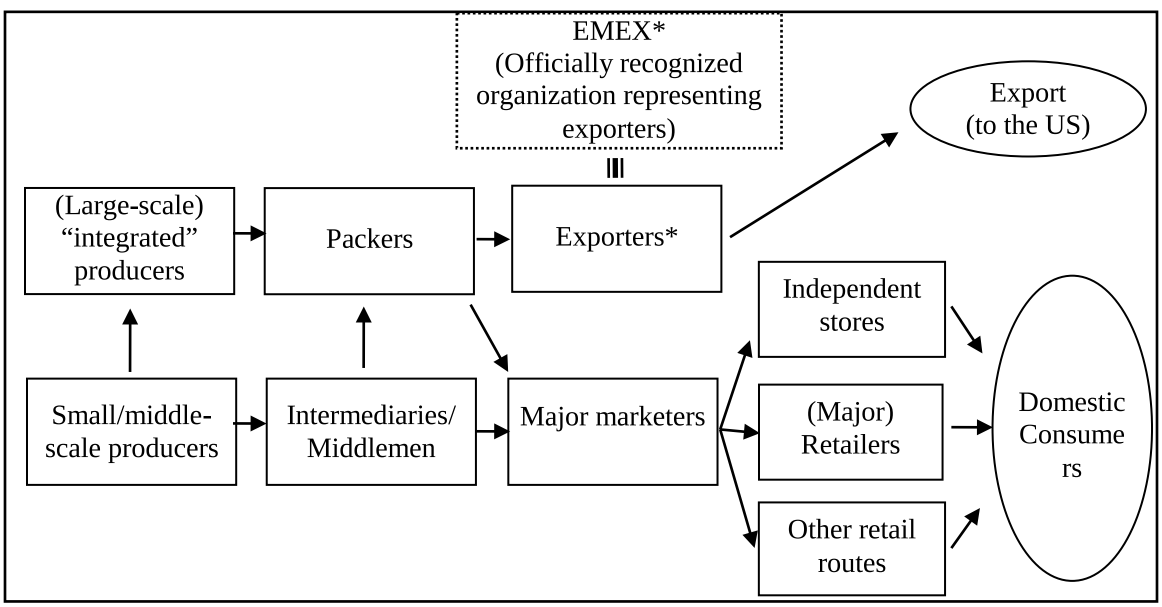

Figure 4-6 Distribution flows of mango in Mexico and to export to the United States Elaboration based on the diagram in PROSERCO (2007:24)
*** Additions by author to the original diagram**

Although about 80% of Mexican mangos are consumed domestically, their export also significantly contributes to Mexico's economy. Mexico exported about 0.2 million tons of mangos, ranking second in the world total export in 2005 (FAOSTATS http://faostat.fao.org/). For Mexico, the United States is the most important purchaser of this commodity. Nearly 90 % of the mango export from Mexico is destined for the United States. The United States also relies on more than 60% of its import of mangos from Mexico (USDA-FAS http://www.fas.usda.gov/gats/ExpressQuery1.aspx). The fresh mango import from Mexico to the United States dates back to the early 1950s. However, the last two decades have witnessed an especially rapid growth, largely because of NAFTA, which came into effect in 1994 (USDA-FAS http://www.fas.usda.gov/gats/ExpressQuery1.aspx).

4.3.4 PS regulations for the export of Mexican mangos

In the fresh mango export from Mexico to the United States, PS regulations to ensure that fruits are pest-free are crucial. Mexican packers/exporters shipping mangos to the United States must abide by the Work Plan, which was agreed upon by APHIS and SAGARPA of Mexico. The Work Plan details technical specifications of the disinfection and the responsibilities of APHIS, SAGARPA, growers, packers/exporters, and their organization, EMEX. As the only organization officially recognized by the United States as representing the exporters, EMEX is responsible for coordinating key activities of the program. Since its founding in 1991, EMEX has been vital to promotion of almost all aspects of the Mexican mango industry, including research on mangos, quarantine negotiations, post-harvest handling, packing standards, and marketing and promotion of the commodity (Wong-Urrea et al. 1996).

HWT is the technique used for disinfection. Disinfection and the palatability of fruits are made possible by precisely controlled temperature and time (115 °F for 65 to 115 minutes). In addition to the HWT process, the Work Plan stipulates numerous conditions, including registration of orchards, certification of disinfection facilities, monitoring of the packing, and on-site inspection by APHIS and SAGARPA officers (or delegated third-party personnel). Practicing HWT engages diverse human and non-human entities, while simultaneously creating certain orderings among or within varying entities, such as "*clean* packing areas for treated fruits" and "*non-clean* unload areas for untreated fruits," within a packing facility. As with the boiling practice of pigswill (Law and Mol 2008), HWT as a mundane practice draws boundaries between pest/non-pest and links different places.

The current HWT was developed in the 1980s. Prior to that, mangos were disinfected with a treatment using ethylene dibromide (EDB, a chemical already abolished for health concerns in the United States) or another technique combining vapor heat and cold water (Sharp et al. 1989; Sharp 1994a). The development of HWT might be seen as the result of complex interactions involving diverse actors, such as fruits, pests, humans, and devices, and negotiations over their unique characteristics, such as a pest's heat tolerance, fruit's quality, equipment's capacity and costs, and health concerns.

Meanwhile, the PFA is an alternative means for mango export to the United States. A PFA is described as "an area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained" (IPPC 1995:37) by eradication and monitoring of the target pest. Generally, once a PFA is recognized by exporting and importing countries, plant products grown there no longer need disinfection. In Mexico, the first fruit-fly-free area recognized by the United States was established in the 1990s in Sonora (Klassen 2005), the state to the north of Sinaloa.

4.4 Research Site: The State of Sinaloa, Mexico

The state of Sinaloa, consisting of 18 municipalities, is located in north-western Mexico, facing the Pacific Ocean and the Gulf of California (Figure 4-8). The total population is 2.6 million. The total land area is 58,000 square kilometers, close to the size of West Virginia. Sinaloa's long territory stretches from northwest to southeast for 560 km, or 350 miles, with the broadest part being 185 km (115 miles) and the narrowest part being 70 km (44 miles). In Sinaloa, where the average temperature fluctuates between 22 and 24 degrees C (71.6 - 75.2 F), different climate types can be identified, including two dominant classes: (1) hot or semi-hot, semi-humid climate with rainy summer and dry areas covering 47.5 % of the total land, and (2) very-dry climate areas with varying temperatures from very hot to hot covering 48.3 % (Meza Campusano 2002).

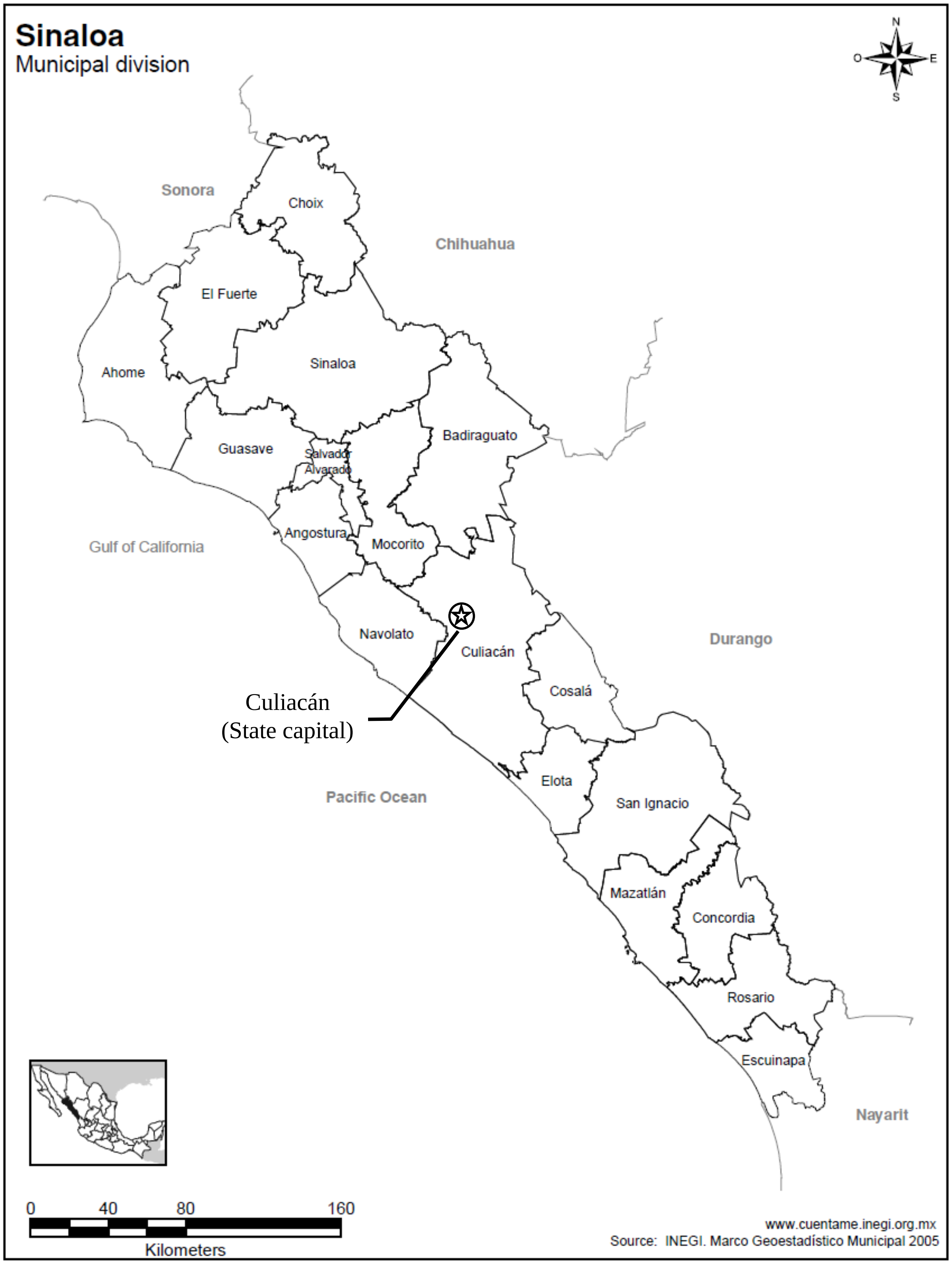

Figure 4-7 State of Sinaloa and its municipalities
Elaboration by author based on a map images provided by INEGI

In selecting the site for research on the globalization of agriculture, meaning an extending web of production and consumption of agricultural products across the world, a pertinent factor is the political-economic backdrop of Mexico. For the last decades, Mexico has been consistently transforming its economic policies towards free-market and free-trade reforms, which have also drastically altered the relationship between the federal government and the people of the nation (Holzner 2010:15). Mexico's political-economic reform also created local political environments varying throughout regions in which diverse political entities have emerged (Holzner 2010:16). Concurrent with the development of economic policies, including NAFTA enacted in 1994, Mexico has been advancing neoliberal policies, including promotion of free trade. However, as revealed by debates over the promotion of free trade in the 2006 Mexican presidential election, Mexico's policy orientation has been highly contested (Bruhn and Greene 2007). This was especially true for rural areas because neoliberal policies included withdrawal of the federal programs for peasants to buy staple foods, and forced them to give up subsistence corn farming and become migrant laborers (Carlsen 2003; Echánove 2005; Echánove and Steffen 2005; Hellman 1999; Kurtz 2004; McMichael 1994b; Myhre 1994; 1998). It is in this political-economic context that this study explored PS regulations in Sinaloa; these regulations make the globalization of agriculture from this site possible.

Its geographic position, being relatively distant from the United States border zones as well as the population centers of Mexico such as Mexico City and Guadalajara, leaves Sinaloa with a challenge in promoting economic development because of higher costs of transportation (López Cervantes 2007:68). Some observers argue that historically, economic development of the state of Sinaloa was arguably associated with the public expenditures by the federal government, which financed the construction of production infrastructures for modernization of agriculture (López Cervantes 2007). Still, primary sectors, such as agriculture, livestock production, and fisheries, are of the most important economic significance for the state. Twenty-six percent (26%) of the active labor population is engaged in the primary sector including agriculture, and twenty-six percent of the total land is dedicated to agricultural production (SAGARPA 2006). While Sinaloa's long coastal shore produces rich marine products, including shrimp, tuna, pen shell, oyster, clam, and mojarra (a type of fish, called silver biddy in English), the state's main economic basis is agriculture (Meza Campusano 2002). It ranks at the top of the country in the production of tomatoes, chickpeas, potatoes, and corn (SAGARPA 2006). Its agricultural production is highly export-oriented. Many commodities are exported, in particular, to the United States. The production of fruits, including mangos, also has significant economic importance both internationally and nationally. Sinaloa, a major mango-producing state in Mexico, exported over 50,000 tons of their fruits primarily to the United States, and ranked second in the country's mango export in 2002 (PROSERCO 2007; SAGARPA 2006).

However, the prosperous export-oriented agriculture of Sinaloa has not been without problems. While its agrarian sector was in constant and prosperous expansion until the 1980s, the entire economic sector of Sinaloa after the 1990s has suffered one of the lowest growth rates in Mexico due to inadequate economic policies, hindering also its farming sector from adapting itself to the global economy (López Cervantes 2007). Among issues drawing the attention of critics are unequal distribution of wealth among crop sectors, concentration and consolidation into fewer farm operators, and environmental degradation, including deprivation of water resources and contamination with agricultural chemicals (Maya Ambía 2007). Also, faced with the effects of the globalization of agriculture on the area, it has been an arena of active farm labor movements (Segura 2005). Recently, rural laborers in the state consistently migrate, seeking work within Mexico as well as beyond the U.S. border (López Cervantes 2007). Another noteworthy, yet highly problematic, economic activity in the countryside that makes the state's name known world-widely is drug trafficking. Although this is an emerging industry in rural Mexico, its emergence in the state of Sinaloa in particular might be attributed to the economic decline since the 1990s; factors that likely lead rural people to narcotics-trafficking are embedded in historically and culturally complex backgrounds (Malkin 2001). Yet, López Cervantes (2007) argues that compared to other states, the Sinaloans have a propensity to take more risks, being inclined to move out to other territories for new or better opportunities, and even to get involved in delinquent economic activities, including the long-existing drug trafficking.

4.4.1 Mango production in Sinaloa

According to Ireta and Guzmán (2002), *criollo* mangos were introduced to the state of Sinaloa, my principal research site, at the end of the nineteenth century. Although since then mangos have been grown in the state, the Florida cultivars, which enabled commercial mango-production, were introduced after the 1970s. As one of the more promising crops for export-oriented markets, mango production in Sinaloa has been steadily growing (Figure 4-8). However, the production of mangos is concentrated in a few municipalities in southern Sinaloa (Figure 4-9), especially in El Rosario and Escuinapa. The number of mango growers has also drastically increased in these two municipalities in the last few decades. Nonetheless, the southern region is where the pest has not been completely eradicated hence it is called an "Area of Low Pest Prevalence" (ALPP), from which mango fruits cannot be exported without HWT.

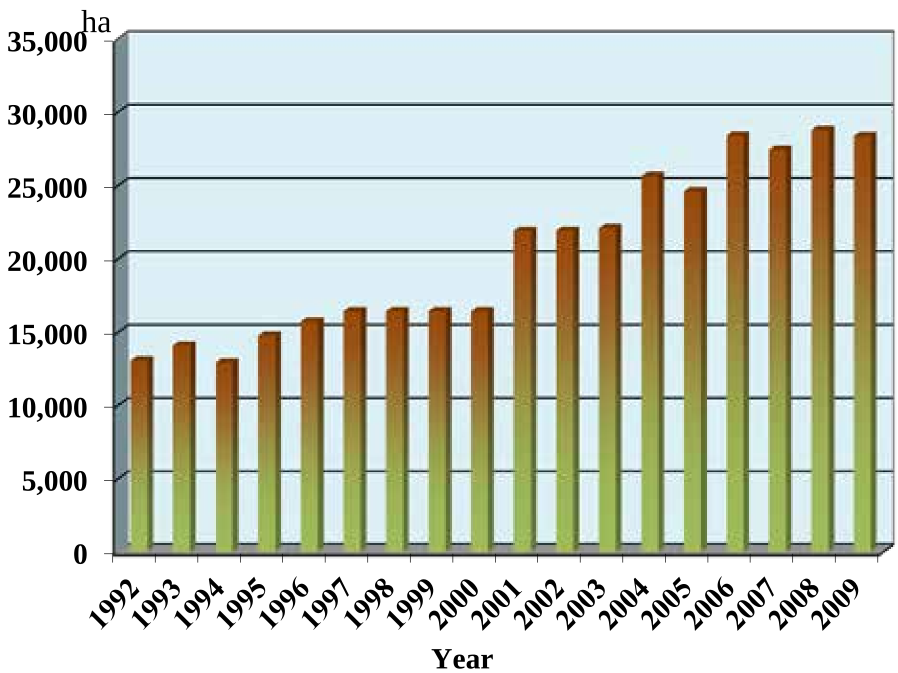

Figure 4-8 Areas planted with mango in Sinaloa (1992-2009)
Source: INEGI

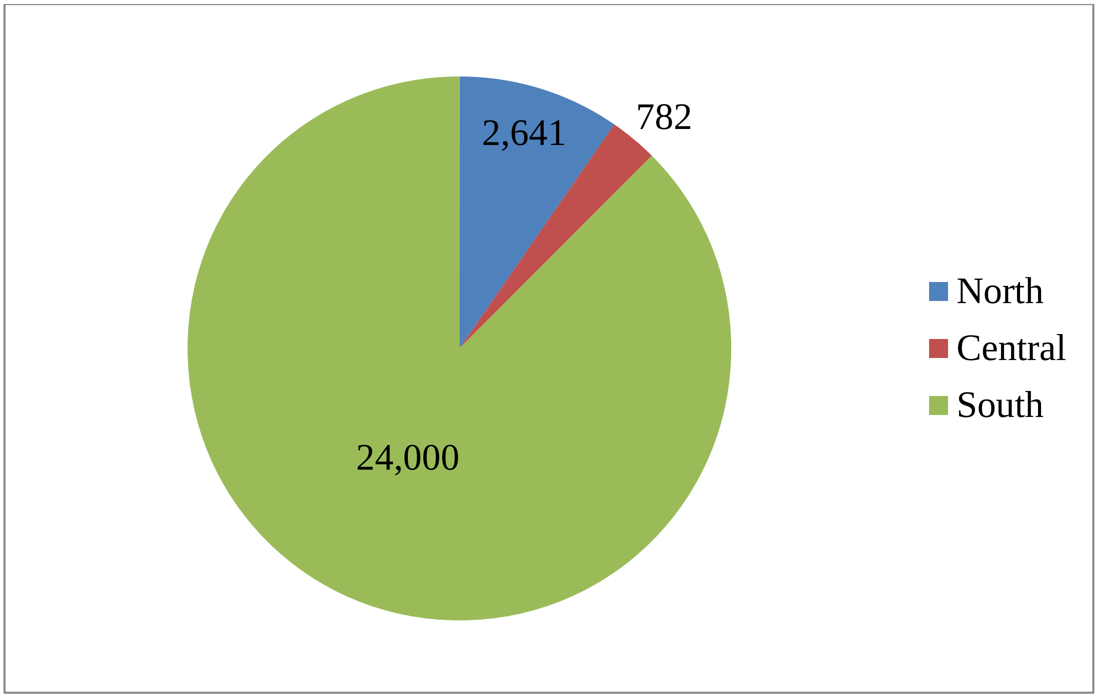

Figure 4-9 Areas planted with mango in 3 regions, North, Central, and South of Sinaloa (hectares)
Source: INEGI

Municipalities in North, Central and South regions of Sinaloa
North (5): Ahome, Choix, El Fuerte, Guasave, Sinaloa
Central (7): Angostura, Badiraguato, Culiacán, Elota, Mocorito, Navolato, Salvador Alvarado
South (6): Concordia, Cosalá, Escuinapa, Mazatlán, El Rosario, San Ignacio
These divisions are based on the pest-prevalence status (Figure 4-10, below). Therefore, North region corresponds to the PFA recognized by the United States; Central region is the PFA recognized by Mexico; and South region is the low prevalence area.

4.4.2 PS regulatory scheme under transition

While the substantial mango export of Sinaloa and the political economic backdrops in the globalization of agriculture are important reasons for the site selection, more critical for my research is that the active "frontline" of the PFA located in Sinaloa is about to shift. In 2005, the Mexican governmental eradication campaign led to the official recognition by the United States that five municipalities in northern Sinaloa are free of fruit flies (SAGARPA 2006) (). Mangos grown in the PFA no longer need HWT to export to the United States. Several other municipalities are awaiting official recognition as PFAs by Mexico and eventually by the United States.

This changing regulation from HWT to PFA in Sinaloa can yield asymmetrical, yet contingent, new orderings. The changing legal and technical specifics of PS regulations will affect people involved in the regulations, such as mango growers, packers/exporters, their employees, and government officials. Some may benefit from the new PFA while others will not. Moreover, a PFA generally needs incessant and active practices engaging diverse actors, such as pest traps installed within the area, release of sterile fruit flies to prevent re-occurrence of the pest, and roadside inspection. These practices perform material politics involving humans and non-humans, engendering socio-material orderings. The shifting "frontline" will clearly illuminate the performance and effect of different techniques (HWT and PFA). For example, the state government might begin roadside inspection to prevent smuggling of potentially *contaminated* items into the *clean* PFA. In the new PFA, workers of HWT facilities might see their jobs under *threat*, while mango growers might see *opportunities* to ship their fruits without the costly HWT. Thus, this research aims to capture enactment of the PFA as material politics that might produce changes in the relationships and conditions among people involved in the regulation.

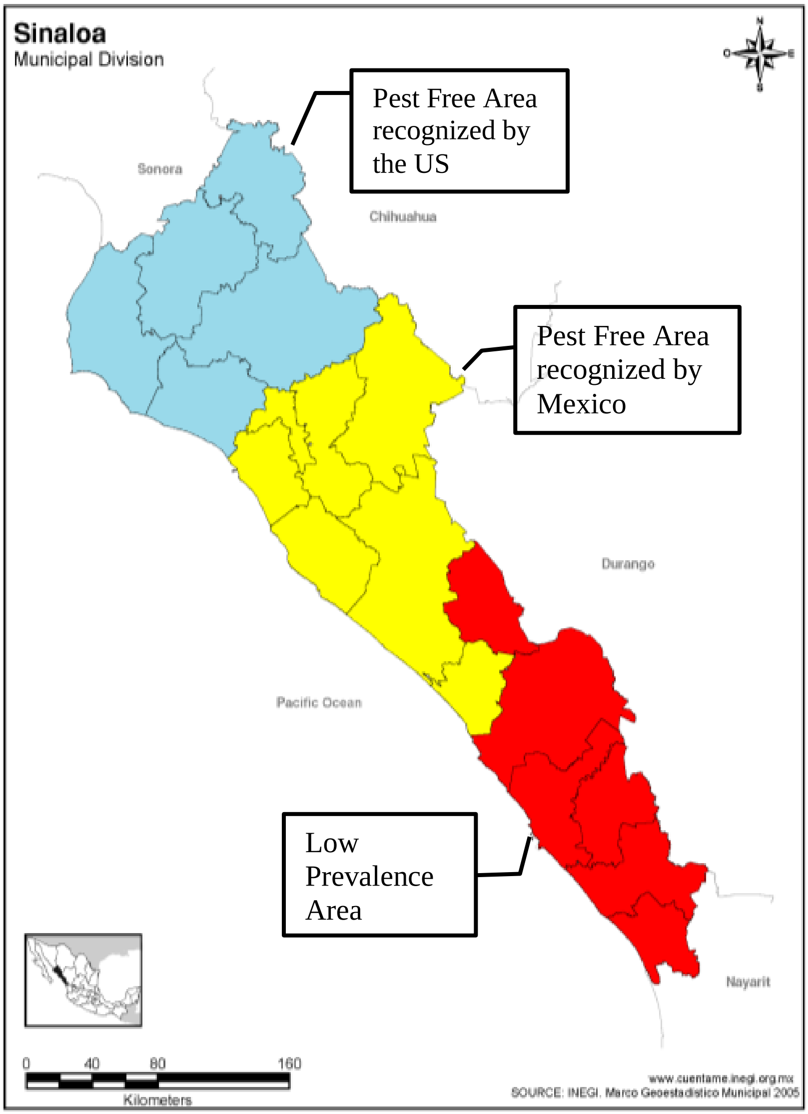

Figure 4-10 Pest (*Tephritidae* fruit fly) prevalence status of Sinaloa
Elaboration by author based on a map image by INEGI

Having presented profiles of the actors and the research site, from the next chapter forward I will demonstrate how PS regulations have developed involving diverse actors, beginning with an analysis of cases where a few *Tephritidae* fruit flies were determined as problematic pests among certain crops.

Chapter 5

Determination of a Pest and Handling of Uncertainties

Beginning from this chapter, I will present findings from the data and their analyses. In this first chapter, using case studies of several *Tephritidae* species and their relationship to a few crops, I will delineate how certain classes of fruit flies were determined to be pests vis-à-vis certain classes of plant. As explained in the previous chapter, because of potential damage *Tephritidae* can cause a variety of crops, many countries take quarantine measures to prevent them from entering the territories. When an importing country attempts to establish a quarantine measure against a fruit fly species, it is critically important to determine whether a certain class of insect is really harmful for a certain plant, which is called "host-status," since it affects the chance for the plant product to have access to a global market. If a plant product is determined as a host plant for a detrimental fruit fly species, then this plant commodity is likely to be subject to a trade restriction by an importing country, including ban of importation. An importing country may require that plants with higher risks to become a host for *Tephritidae* go through pre-export disinfection treatments, such as HWT for mangos.

It can be argued that the significance of host-status determination has been growing in today's globalizing agricultural and food provision market. For, on one hand, an import ban of non-host (i.e., safe) plant products can be taken as distorting equal access to the country's market because under today's scheme of international trade regulations, a country cannot pose unnecessary import restrictions (Henson and Loader 2001). On the other hand, when a certain host plant is determined as non-host, while that commodity may be traded without restriction, producers of the importing country could be upset because of a potential threat to their fields of production or to their share in the market in the country. Hence, as reviewed in Chapter 2, under the WTO rules SPS measures to prevent the spread of agricultural pests have to be based on scientific knowledge to minimize distorting trade barriers.

Moreover, the host-status determination has implications more than the pest risk as such, to which an importing country can be exposed through trade. Once a quarantine regulation is imposed based on a host-status judgment, values or norms (e.g., one may say that a *good* production practice to reduce potential risks *should* be introduced) would emerge among human and non-human actors enrolled in the production of a global commodity such that they are "disciplined" to conform to regulations governing globalizing agriculture. Thus, determining the host-status of a certain fruit fly species vis-à-vis a certain plant product has significant political, economic, and moral implications for globalizing agriculture.

However, determining the host-status is not as easy as it may sound, since, as I alluded to previously with one of the working hypotheses in Chapter 3, pest-host determination processes can entail and expose uncertainties of behaviors of insects, plants, and/or humans. This is premised on the claim by STS since the 1970s that scientific knowledge must be interpreted as the outcome of a temporal settlement of contestations, and therefore flexible, negotiable, and open to different interpretations (Bloor 1991; Collins 1983; Yearley 1984; Yearley 2005). My analysis, by "following contestations" over pest-host relationships and drawing on insights from STS including ANT and systems theory, will examine how science handles uncertainties of evolving relationships between pests, plants, and humans; it will also examine how scientific knowledge as an outcome of settlement of contestations over the uncertainties will be fed into other domains of society, such as law. The chapter will conclude by suggesting that while science, through the supposedly "objective" determination of pest-host relationships, can generate risk knowledge for legal or administrative decision making, this process also conceals uncertainties and simultaneously engenders asymmetrical relationships between those who are involved in and those who are excluded from the decision making.

5.1 Contingency in Determination of a Pest

First of all, what is a pest? In general, a pest means an organism (insect or animal) that is harmful to humans or human concerns, including crops, and thereby has extended connotations, such as an epidemic disease or an annoying person (Webster's Third New International Dictionary; Encarta World English Dictionary). Fundamentally, however, what constitutes a "pest" can be elusive. For instance, among different cultural/semantic systems, concepts of pests can vary considerably. Works drawing on ethno-entomology or ethno-phytopathology—investigations of classification systems of insects and pests in different cultural contexts—have documented variability in what constitutes a pest or not and in how farmers control or avoid insects damaging crops (Bentley 1991; Bentley et al. 2009; Bentley and Rodriguez 2001; Bentley et al. 2005; Bentley, Rodríguez, and González 1994; Gurung 2003; Morales and Perfecto 2000). Morales and Perfecto (2000), for instance, have noted that farmers in the Guatemalan Highland insisted they had no "pests" in their *milpa* (traditional intercropping farming) because their concept of "pest" differs from what the corresponding Spanish term, *plaga*, would mean. The farmers' concept of a pest hinges on whether the insect causes "economic damage," which depends largely on the degree of tolerance of the farmers; and the farmers are quite tolerant of “damage” by herbivorous insects on corn, their staple crop, because they, according to their local religious belief, see it as a “share” for insects. Likewise, van Schoubroeck (1999) has reported that some religions, such as Buddhism, preach against unnecessary taking of lives, making farmers reluctant to apply pest control measures.

Rapidly globalizing agriculture also has much to do with changing perceptions of what constitutes a pest. The Guatemalan farmers Morales and Perfecto (2000) studied were aware that non-traditional commodities for exports, such as broccoli, were often harshly damaged by pests. Gurung (2003) also noted that the introduction of new crops or varieties converted native insects into “pests”—in Nepal, “pest” became a problem only after high-yield rice varieties had been introduced. In addition, obviously, the fruit fly became an important problem to mangos in Mexico only after the plant was introduced to the country and came to be regarded as an important potential export crop. Importantly, in the case of the Guatemalan Highland, damage to export-oriented commodities was not tolerated because consumption by insects is judged as “damage” by outside buyers. As Gurung (2003) indicated, if growers consider “losses” (from the outsider’s view, of course) of plant products irrelevant, then they would not control insects eating the plant, and therefore it would make little sense to launch a plant protection campaign. However, if the farmers were to ship products to a distant place where “share for insects” is not tolerated, then they have to see the bug as harmful “pests.” Thus, discourses regarding who, and based on whose interest, determines (or are deemed to determine) what constitutes damage on a plant product can have a significant impact on those who produce some plant products and the way they produce them, especially if the product is shipped to a different place where different categories or semantics of "damage" are adopted.

Such elusiveness of the concept of a pest does not seem completely dissolved even in the globally accepted, "official" definition of a (plant) pest. A pest is defined "officially" in International Standards for Phytosanitary Measures (ISPM) No.5, a lexicon of terms and definitions related to PS measures compiled and published by IPPC, as follows: "pest - any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products" (IPPC 2007:12). If ingenuously interpreted, this means that all herbivorous species (*Homo sapiens* included) should be considered pests. While obvious exceptions such as the human must have been (implicitly) excluded from this definition, a more specified concept of a pest subject to PS measures, namely, "quarantine pest," is provided in the same lexicon: "quarantine pest - a pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled" (IPPC2007:15). This seemingly clear-cut specification as such, however, does not necessarily explain what constitutes "potential economic importance," how it is measured, and the extent to which the economic importance is considered, and so forth.

The elusiveness in determination of a pest and its hosts (or a "host range") calls for scientific knowledge generated by experts, including entomologists, plant pathologists, and economists. Science or scientific knowledge is expected to provide objective and neutral bases for pest-host determination. As some entomologists point out, political or economic interests may distort scientific objectivity: "economic, social, and political considerations . . . inevitably creep into the process of host plant status designation" and “science-based decision-making processes represent the only acceptable mechanism to resolve any dispute on this matter” (Aluja and Mangan 2008:486-7). Nonetheless, the difficulty of host-status determination lies not only with the so-called political and economic interests, especially in the determination of pest-host relationships in the case of *Tephritidae* fruit flies.

As living organisms, fruit flies have very complex characteristics, and their behaviors vary flexibly and contingently through interaction with their milieu, which includes humans. In essence, certain fruit flies attack specific fruits on some occasions, but in other places or circumstances they may prefer other plants. Such contingency or uncertainty can make it difficult to make a clear-cut judgment of a fruit fly species’ host-range. Hence, for entomologists, “Host status should be regarded as a continuously evolving phenomenon” (Cowley, Harte, and Baker 1992:312). Nonetheless, despite the quite long history of this pest being subject to plant quarantine, attempts to develop a comprehensive and systematic scheme to determine the host-status of fruit flies seem to be relatively new and have been contentious, not least because of the species’ biological and ecological complexity (Aluja and Mangan 2008).

Given the contingency of pest-determination as outlined above, in what follows a few case studies will illuminate how fruit flies were determined to be pests against certain plants (host plants). In doing so, the analysis will put specific focus on how contingencies and uncertainties in the process of determining pest-host relationships were handled, concealed, and maybe (re)emerged. To this end, scientific and technical journal articles of agronomy, entomology in particular, and documents produced by governments and international organizations were analyzed. These documents were collected through electronic, on-line databases such as *Agricola* and *Web of Science,* as well as at libraries in Mexico during my fieldwork. The case studies on host status include mainly two agricultural commodities, avocado and manzano (rocoto) pepper, as to several fruit fly species, including *Anastrepha ludens* (Mexican fruit fly)*, A. obliqua* (West Indian fruit fly)*, A. serpentina* (Sapote fruit fly)*, and A. striata* (Guava fruit fly), along with a few other similar cases concerning *Tephritidae* fruit flies, which are found mainly in Mexico and subject to plant quarantine control measures by the United States.

5.2 Case Study 1: Mexican Hass Avocado — "Uncertainties Transformed"?

The first case concerns how the host-status of avocado (*Persea americana*) of the Hass variety produced in Mexico was determined. Detailed accounts of politico-economic backgrounds and the consequences or impact of the regulation on Mexican farmers were skillfully documented by Lois Stanford (2002). She has revealed how local elites' lobbying mobilized political actors towards adopting the quality standards of the Mexican avocado in the state of Michoacán, while small scale growers, regardless of their willingness, or unwillingness, had no choice but to accept the adopted standards, thereby bearing a large burden. My focus, meanwhile, was on how uncertainties or contingencies were handled in the process of scientific judgment over the host-status of fruit flies against avocado.

In 1997, after the long import ban since 1914, the Mexican avocado of the Hass variety was allowed to be imported to the United States. Since then the import regulation has been relaxed such that the export season extended. This ban-lifting and relaxation of the regulation was made possible by collaborative research conducted by US and Mexican researchers, with the conclusion that "commercially cultivated and marketed

Hass avocado should not be considered a natural host of" four Mexican-native fruit fly species (Aluja, Arredondo, and Diaz-Fleischer 2004; Enkerlin et al. 1993). These researchers found no infested fruits out of about 22,000 sampled (two studies combined) in groves and packing houses. Such massive sampling would make disputing the credibility of the results so costly that no one would attempt to overturn the findings (Kanamori and Nakajima 2002). They employed field as well as laboratory experimentation to examine whether fruit flies would lay eggs in fruits, as well as whether larvae would develop there to complete the insect's life cycle. The result was that only very few fruits under "forced no-choice" (i.e., fruit flies have no other fruit to lay eggs) conditions on trees were found infested but yielded no mature adult flies. In one of the studies (Aluja, Arredondo, and Diaz-Fleischer 2004), for example, 5,200 fruits were exposed to 26,000 female fruit flies, but none was infested. However, they also found that fruits may be susceptible to one of the examined fruit fly species, Mexican fruit flies (*A. ludens*) under "forced no-choice" conditions in the laboratory when exposed to the pest for a longer time period after harvest.

Certainly, their verdict that "commercially cultivated and marketed Hass avocado should not be considered a natural host" is plausible. My argument is not against the conclusion and the process to determine whether or not the Hass is a host. My point is that the researchers control as many uncertain factors as possible to reduce complexity. They limited the variety (cultivar) for the testing only to "Hass," used fruits of as much uniform quality as possible, exposed to fruit fly populations from the same origins, and so forth. Also, knowledge established from past research served to preclude further research inquiries. For example, as they had learned that the "life cycle of the concerned fruit fly species does not exceed more than 35 days," they made a reasonable decision to stop exposure of fruits beyond this expected life span. Along with the aforementioned example of massive sampling, this is in parallel with ANT's observation on the way disputes over a certain hypothesis (e.g., hormone's structure) is settled and halted using a difficult-to-overturn credibility of a device (e.g., mass spectrometer) (Latour and Woolgar [1979] 1986). In addition, they found a very interesting mechanism of this crop which resists the pest's invasion. That is, when attacked by a fruit fly, Hass avocado forms calluses at the point of intrusion, which inhibits the pest's further normal growth in the fruit.

However, despite the relatively clear verdict, uncertainties were not completely eliminated. As mentioned, fruits exposed for a longer period after harvest, or unhealthy or diseased fruits, might become susceptible, perhaps because the resistance mechanism does not work well. Under these assumptions, fruits to export should be grown and handled under stricter conditions in order to reduce fruits of bad quality, and to ensure proper and quick handling of harvested fruits. This would call for "institutionalized" regulations such as statutes and other administrative programs over production and shipping processes to make fruits eligible for export to the United States. This is exactly what was implied when the researchers concluded, "commercially grown and marketed fruits are not host"—this in turn implied that poorly-grown and improperly handled fruits could be susceptible to the pest.

And, it seems, an administrative decision was made in a particular manner, even if it is fed apparently "objective" scientific knowledge. Based on assessment research (Aluja, Arredondo, and Diaz-Fleischer 2004), USDA-Agricultural Research Service

(USDA-ARS) sent a comment to USDA- APHIS, making it clear, “It is the ARS view that the small infestation rate observed in Hass avocado, in the context of other avocado experience, is sufficient to classify Hass avocado as a very poor host of Mexican fruit fly” (USDA-APHIS 2004); however, it added:

> It is not an ARS role to take a position on whether low level infestation rate such as seen in the case of Hass avocado poses an important quarantine risk. Nor is it an ARS role to suggest whether mitigation is needed or the type of mitigation required, should APHIS decide one is needed. ARS defers to APHIS’ experience and expertise in risk assessment and management and notes that APHIS successfully manages many commodities with quarantine risks (including avocados) entering the U.S. from all parts of the world. (136)

Thus, scientific communication provided by ARS, while feeding a “scientific” judgment over the host-status of Hass avocado, delegates to the administrative domain (undertaken by APHIS) a decision regarding whether specific administrative/political procedures would be needed. This “delegation” reflects the concept of the Risk Analysis model, a standard governance scheme in handling of risks, which consists of three different activities, that is, (scientific) risk assessment, (administrative) risk management, and risk communications involving all stakeholders, including scientists, administrators, and a concerned public (Yamada 2004). In this model, which reflects the functional differentiation of society, to make a decision over whether to adopt a new risk mitigation measure or just relax the past regulation, the administration (APHIS) would have to handle lots of “political” uncertainties, such as resistance from U.S. avocado growers, while it can (at least pretend to) attribute the legitimate basis for the decision to science, which in turn is (or pretends to be) in a separate domain from political uncertainties.

Furthermore, one of the authors of the study asserted in another article that Host-status should be reviewed in 15-20 year cycles because of the possibility of mutation of the fruit fly population, which is also a source of the pest species’ contingency, and may enable, for instance, the insect to break a plant's resistance mechanisms (Aluja and Mangan 2008). It should be remembered that not only between humans and fruit flies, but also between fruit flies as pests and plants, competitions for their survival are happening. In essence, as entomologists are well aware, the scientific host-status determination is not necessarily the final, ultimate verdict, but rather should be treated as a temporary pause in uncertainties or contingencies (Aluja and Mangan 2008; Cowley, Harte, and Baker 1992).

5.3 Case Study 2: Manzano Hot-pepper — Unquestioned "Fact" and Remaining Uncertainty

Another case concerns the discovery of Mexican fruit flies in manzano, or rocoto, peppers (*Capsicum pubescens*) in 2003 at the import plant quarantine inspection at the U.S. border, and the following investigation of how this unusual infestation occurred (Thomas 2004). Previously, this crop had not been considered a host for fruit flies. However, the discovery prompted laboratory tests and careful field observation, which revealed that Mexican fruit flies (*A. ludens*), though in rare conditions, could infest this commodity. The U.S. government then exercised import quarantine regulations on this commodity.

How did this unusual infestation happen? A researcher I interviewed in Mexico revealed, first of all, that earlier studies done in the early twentieth century left only very ambiguous records regarding whether *A. ludens* attacks this pepper, and there had been no records since then. In addition, this pepper contains much capsaicin (piquant substance in hot peppers) and is one of the hottest (spiciest) pepper species. The Mexican researcher in the interview suggested that with no record of infestation, perhaps everyone just believed, or probably didn't even doubt, that capsaicin would inhibit the growth of maggots in the pepper fruit. In other words, they just "blindly" believed it. The unquestioned belief, with no proof, eventually became an unquestioned "fact," concealing the uncertainty of the pest's behavior.

However, it is the case that Mexican fruit flies rarely use this plant as host; this pepper is too hot to be their preferred host. The infestation case was brought about by many contingent factors, which, unlike laboratory conditions, were largely unpredictable and uncontrollable for scientists. The pepper found infested was a new crop to the region where farmers were not familiar with the crop and potential infestation of it. There were not plenty of other more preferred host plants. Weather conditions and the ways the crop was growing, especially under shade in the field, might alter the pest behavior—some fruit fly species were reported to be prone to prey on plants under shade (Aluja and Mangan 2008). Finally, as reiterated, fruit flies' foraging behaviors are flexible. Thus, the infestation occurred, and the concealed uncertainty re-emerged.

In fact, a similar case of a conditional host has been reported between lemon and Mediterranean fruit fly (medfly; a non-native of Mexico) (USDA-APHIS 2008a). Based on reviews of over 90 scientific articles, a team of experts of USDA-APHIS concluded that while lemon fruits were a conditional host for medfly, an immature fruit (green) was not a host. Interestingly, one of their reviewed articles, which was very old (published in 1948), suggested that "common acid lemon [was] 'immune' based on chemical and physical factors" (USDA-APHIS 2008a:6). However, subsequent studies have shown in some cases the susceptibility of lemon, and in other cases not, depending on several factors, including fruit maturity, or whether a puncture on the fruit was found, and so forth. A consensus among the APHIS experts was that there was "uncertainty about the shade of light yellow at which lemons change from being non-susceptible to becoming susceptible, but an overripe or over-mature condition leads to susceptibility, especially in the presence of high Medfly densities" (p3-4). According to this conclusion, USDA-APHIS amended the U.S. PS regulations in 2010 such that lemon is now subject to PS regulations (Federal Register 12961, Vol. 75, No. 52).

5.4 Discussion and Summary

In the reviewed host-status determination cases, uncertainties and contingencies were dealt with, halted, and concealed. In the first case regarding Hass avocado, for instance, "established knowledge" from past research "shut down" further inquiries. In the second case, the absence of records, blind belief, and neglect or ignorance kept halting and concealing uncertainty of the pest, which eventually reasserted itself in 2003. Scientific knowledge thus established as to a host-status was an outcome of processes that handle and conceal, and thereby settle disputes over uncertainties of acts of pests, plants, and humans.

The main argument here pertains to how scientific knowledge of the pest-host relationship was developed, and how the knowledge as the basis for regulatory activities in the field was fed into different domains of society. In ANT's term, this process is called "translation," through which different actors handle and transform knowledge and/or objects, expanding the network of associations (Callon 1986). As will be shown in detail in later chapters, scientific knowledge as to whether an insect is a pest vis-à-vis a plant constitutes the basis for PS regulatory activities established and enacted by administrations (i.e., government) and legal systems (i.e., statutes). Hence, the consequences of scientific determination of pest-host relationships, or host-status, do not remain in the network of science, but extend its influence throughout society. From what ANT calls the "center of calculation" where scientific knowledge is accumulated, actors/networks develop further networks, mobilizing a variety of resources including technologies and legal/administrative regulations to overcome resistance, such that a "network of control" builds up (Latour 1987). Those who are touched by the network would become subject to control, which embodies a moment of enactment of power, that is, drawing a distinction between those who or that control and those being controlled.

However, this "translation" cannot be taken as mere transformation of certain information from one actor to another; but rather, according to systems theory, it entails concealment of the uncertainties. Systems theory suggests that differentiated domains of society operate by handling risks according to their own programs, concealing uncertainties that persist in science (e.g., as scientists knew that fruit flies could behave volatilely, the knowledge of host-status was in fact temporary) (Hijikata 2002; Luhmann 1993). In other words, in the process of extending the network of control, different networks, including law and administrative systems, conceal uncertainties, not resolving them completely. Hence, an important insight from the cases presented above is that the temporarily concealed uncertainty does not disappear, but is just transformed into risks for other domains to handle (Hijikata 2002). As the ARS's statement above indicated, science withdrew from judging whether administrative or legal risk mitigation measures were needed. The established regulations, in turn, might bring to the fore different types of risks such as "human errors" in operating regulatory programs. Despite the apparent robustness of the network of control, the whole system, which appears to be working “normally,” may in fact be quite vulnerable, especially when different systems are involved, increasing internal complexity (Perrow 1984).

Also, since the uncertainty is not completely solved but just concealed, the risk would appear as more tangible to those who are discontented with the decision. For example, Californian avocado growers expressed their concerns over USDA-APHIS’s continuous relaxations of import restrictions on Mexican avocados associated with a few critically important pests including Mexican fruit flies (Vogel 2000). Although APHIS’s decisions to relax rules were based on the fact that “seven years of Mexican avocado shipments to the U.S. [had been] without a pest problem,” to the Californian avocado growers, “past performance of the import program simply is not a reliable indicator of its future success,“ and decisively important was that it was not researchers nor administrators, but the very growers who “have first-hand experience combating insect pests from Mexico—at a cost of millions of dollars annually” (California Avocado Commission 2004). Such concerns were officially recorded and handled as public comments to which APHIS meticulously responded with a variety of justifications, whether science-based evidence, or claims for adequacy of legal measures (e.g., 66 FR 55530, published November 1, 2001). With this formal administrative procedure, the concerns of the avocado growers were blocked off; but, even if APHIS gave “rational” answers to the concerns through the formal channel, the possible introduction of the pest and its hazards to the growers would never vanish.

Likewise, U.S. citrus growers expressed their concerns about the risk of Mediterranean fruit fly when USDA-APHIS decided to resume importation of clementine from Spain after several insects of this species were intercepted from the commodity in

2001 (Livingston, Osteen, and Roberts 2008; Federal Register Vol. 67, No. 203). The U.S. fruit growers' concerns about the pest risk indicated that the pest risk was still *pertinent* to them and posed *real* threats to their survival, because they would be economically affected if the pest was really introduced. Their perceptions of the threat of hazard would not be solved easily, even if the administration and experts scientifically concluded that the risks would be minimal and made administrative/legal decisions based on cost and benefit analyses with reference to the entire nation (primarily consumers), rather than the growers. With insights from ANT and systems theory, I argue that although the extending network of control would overcome resistances by mobilizing a variety of resources, resistances would not disappear but only keep smoldering, as it were, or just be temporarily halted at best. The growers' concerns might sound more plausible when we are reminded of the vulnerability of control systems faced with the unpredicted resurgence of concealed uncertainties. Indeed, the interception cases of Mexican fruit flies in manzano hot peppers and medflies in Spanish clementine, as presented above, seemed to have occurred in unusual and unanticipated conditions (Livingston, Osteen, and Roberts 2008; Thomas 2004).[15]

Thus, works employing systems theory to understand risk (Komatsu 2003; Luhmann 1993; Nassehi 2002) emphasize the difference between "risk" and "danger," while commonly "risk" is juxtaposed with "safety." "Risk" is hazard perceived by those who are included in decision-making and hence deem the hazard under control, while

[15] Livingston, Osteen, and Roberts (2008) mentioned that "[i]nvestigators determined that the infestations were due to a number of factors, including unseasonably warm weather conditions and above-average medfly populations during the 2001-02 growing season, susceptibility of early-season clementine varieties, and problems with the application of cold treatment" (P21)

“danger” is hazard perceived by those excluded from decision-making but affected by the decision, who therefore feel as if the hazard is out of control. Therefore, theorists employing systems theory pay attention to how and who makes a decision concerning risks. In the presented cases, the entomologists and/or economists engaged in the estimation of the pest risks and the benefit/cost calculation would consider the hazard controllable (by concealing residual uncertainties). On the other hand, the hazard would likely appear more uncontrollable to those fruit growers opposed to the decision because for them threats caused by the residual uncertainties would be real and pressing.

To address the incongruence between decision-makers and those affected by a decision, on one hand, it is vital to call for more open, transparent, participatory or “democratic” processes in addition to scientific decisions as bases for regulatory administrative actions, rather than letting “experts” monopolize them (Fujigaki 2002; Massimiano and Neresini 2007). Indeed, comments opposing the results of pest risk analyses and proposed rules based on them were made through public comment opportunities arranged by the U.S. government to ensure transparency in decision-making processes. Meanwhile, however, making decisions through such “open” processes, hence spending more time on making the decision, could provoke among some parties (e.g., growers of a crop waiting for an export permit hinging on a decision by an importing country) a perception of a different kind of danger (e.g., lost economic opportunities by a deferred decision-making) (Komatsu 2003). Fruit fly pests, furthermore, would not care whether a decision was made “democratically” or whether knowledge is monopolized by experts. The pest would only resurge when it can regardless of how scientific or democratic a decision was made as to its risks. Thus, the difference between “risk” and “danger” would not disappear but continue to (re)emerge in different contexts of networks. It is therefore an essential task for sociologists to keep elucidating in what contexts, by and for whom, a decision is made, and who will be affected by it.

To summarize the findings and analysis, this chapter has elucidated how scientific determination of host status was made regarding a few *Tephritidae* fruit flies. While science was expected to provide objective and unbiased knowledge about uncertainties of fruit flies or any other biological organisms, the host-status determination process entailed concealment of, rather than complete solutions to, uncertainties, which were temporarily halted, pushed aside, or ignored. In the meantime, scientific knowledge of host-status would eventually be fed, or translated, into other social domains, such as law and administration, thereby constituting and extending the network of control, which embodied the enactment of power and drew the distinction between actors who control and those subject to control. The uncertainties remaining in science were transformed into risks to be handled in other social domains (e.g., legal and administration systems), while science itself shied away from making legal or administrative decisions regarding risk mitigation. Through the translation, also, the asymmetry between those who were involved in making decisions regarding risks emerged, dividing those “experts” who were deemed responsible for decisions and those who were discontented with the decision. In the following chapters I will delve into how PS regulations as the network of control were enacted based on the scientific judgment of host-status as well as other scientific and technical knowledge about the fruit fly pests. Presenting details of PS activities, I will demonstrate how this regulatory network extended its reach of control over a variety of entities from packing houses to non-farming areas, beyond spatial, organizational, and institutional boundaries.

Chapter 6

Engaging Humans and Non-humans for Control I:

Post-harvest Treatments

The previous chapter illuminated how a specific class of insects, *Tephritidae* fruit flies, are determined to be an agricultural pest vis-à-vis plants. Yet, the regulation makes not only the distinction between pest/non-pest as to existing objects, but also *more* actively converts potentially infested objects into pest-free. The following three chapters will focus on the process through which diverse agents are engaged to make objects (e.g., mango commodity, packinghouses, and certain geographic areas) pest-free. The network of PS regulations as material politics (Law and Mol 2008) engages diverse actors, whether so-called human or non-humans, and functions continuously to engender the pest/non-pest distinction. It was posited that processes to make the commodity, mangos, pest-free would engage a variety of humans and artifacts, including machines, tools, documents, and statutes. ANT can be used to gain perspective on the work of PS regulations, which constitute a process to build a network or association of heterogeneous actors to make possible the distinction between pest and non-pest. From the systems-theoretical perspective, this creation of the network is a process of selection and simultaneous exclusion of specific actors as different networks (i.e., systems) with different operations that may be incompatible with other networks.

These overarching theoretical perspectives guide the following three chapters, which will present the key components of PS regulations for the mango export program, that is, the post-harvest treatment, the campaign against fruit flies, and the role of CESAVESIN. This first chapter of the three chapters will trace how several post-harvest treatments have developed to enable the export of Mexican mangos to the United States. The central theme is that the development of various treatment techniques was a process of engaging and assembling different artifacts into a relatively spatially concentrated apparatus to annihilate the fruit fly pest. This assembling process was accompanied by the classification and exclusion of particular objects as well as meticulous controls over the treatment processes. The next chapter (Chapter 7) will highlight the national campaign against fruit flies of Mexico. As with the post-harvest treatment, the campaign is constituted as the assemblage of a variety of regulatory measures including legal, chemical, and biological agents. Nonetheless, this newer regulatory scheme employs more spatially diffusive measures to exert controls over not only sites of production and distribution of mangos but also non-farming areas. Chapter 8 will illuminate how CESAEVSIN and other new entities including third-party organizations enact the entire regulatory network in a distinctive political climate of neoliberal reform in Mexico. With their multi-faceted polyvalent characteristics as quasi-governmental and civic/private entities, CESAVESIN and third-party organizations aptly mobilize growers and allocate resources with flexibility to enable the operation of the spatially and institutionally diffuse regulatory network. Yet, the chapter raises critical assessments of the legitimacy of authorities as well as their limitations, which resulted in frustrations among growers.

6.1 Post-harvest Quarantine Treatments: Overview

Disinfection treatments for harvested fruits are the principal PS measure currently enabling the export of Mexican mangos to the United States. A variety of post-harvest treatments using both chemical and non-chemical materials, such as heat-treatment using hot water, vapor and heated air, cold treatment, fumigation by ethylene dibromide (EDB) and methyl bromide (MB), pesticide dipping, wax-coating, and irradiation, have been tested and practiced to enable trade of mangos and other commodities susceptible to *Tephritidae* (Follett and Neven 2006; Hallman and Quinlan 1994; Mangan and Moreno 2002). Technical development always opens new possibilities for different commodities and people growing them to exploit new markets. Reefer, or refrigerated containers, for instance, made possible disinfection of citrus fruits by cold air during transportation without causing damage to fruit. Use of irradiation nullifies the capacity of fruit fly larvae to emerge or reproduce offspring without diminishing the quality of a product. The irradiation method enabled trade of some fruits such as guava, which are not tolerant to other disinfection methods. Perhaps mangos are one of the best examples of fruit commodities that post-harvest treatments have made eligible for global trade.

However, many challenges in post-harvest treatments have been reported. Pesticides used for fumigation provoke concerns about health and environmental issues. For instance, despite its effectiveness as a fumigant and its low cost, EDB turned out to have carcinogenic, mutagenic, and adverse reproductive risks. Given this, the U.S. EPA banned its use in 1984, which eventually led to the introduction of hot water treatment (HWT) of mangos. Although in some products EDB can be substituted by MB, MB treated mangos can spoil faster. Also, as MB is linked to depletion of the ozone layer, its use has been severely reduced under the Montreal Protocol on Substances that Deplete the Ozone Layer and alternatives have been investigated.[16] Costs for additional treatments are another burden that shippers or growers try to minimize. As Hallman and Quinlan (1994) have reported, untreated Mexican mangos have been smuggled into the

[16] However, since the Montreal Protocol allowed the use of this material for plant quarantine purposes, MB is still commonly utilized as a post-harvest fumigant.

United States despite the availability of HWT and other post-harvest treatments. Different types of damage to the fruit by post-harvest treatments are persistent problems of many post-harvest treatment (McDonald and Miller 1994). For instance, HWT and MB as substitutes for EDB fumigation shortens shelf-life of mangos or causes “burn” in their pulp. Researchers and growers are always seeking new alternative treatment measures. When an existing post-harvest treatment encounters a challenge, new measures to ensure pest-free status and palatability of products evolve to allow existing or new products to be traded to distant places. Thus, “Phytosanitary Regulations Shape Fruit and Vegetable Trade Patterns” (Romberg and Roberts 2008).

Importantly, changes in PS regulations accompanying new treatments, while enabling the export of mangos and other fruits, have simultaneously and continuously altered the socio-material landscape involving humans and non-humans. That is, once a treatment measure is modified or altered with other means, new technical specifications, including novel devices, procedures, and standards (e.g., hot water tank, temperature and time of heat treatment, classifications and standardization of mango fruits) will be introduced; these specifications function to categorize and sort out non-humans simultaneously (re)establishing their values and the social life of things (Bowker and Star 1999). Humans, engaged in the specific processes associated with the regulations, are categorized (e.g., an inspector of mangos), sorted, or (re)evaluated according to their roles in the enactment and/or how well they do it (e.g., a good inspector). In the following analysis, these outlined theoretical considerations will be applied in tracing how the changing post-harvest treatments to kill *Tephritidae* have made possible the export of Mexican mangos and altered landscapes surrounding actors engaged in the regulations.

6.2 Vapor-heat Treatment: Dawn of Post-harvest Treatment for Mexican mangos

Historically, the Mexican mango export has been conditioned by PS regulations to control some *Anastrepha* fruit fly pests. In September 1945, the USDA approved importation of oranges, pomelos (grapefruits), and mangos of Manila variety produced in Mexico, if they were treated with vapor-heat of 110 degrees Fahrenheit for more than 14 hours (Secretaría de Agricultura y Fomento, Sección de Investigación y Divulgación 1945). Insights about the heat susceptibility of fruit flies (Weddell 1931) led to the development of vapor-heat treatment (VHT) and a similar forced hot air treatment (FHAT)[17] as quarantine treatments against fruit flies to sterilize citrus in Florida, California, and Texas, and other fruit commodities in various places since the late 1920s through 1930s (Balock and Starr 1945; Hallman and Armstrong 1994). The development of these heat-processing techniques in the United States was in response to the growing recognition of the threat of economic loss in citrus industries caused by *Tephritidae* pests, including Mediterranean fruit fly (*Ceratitis capitata*) and Mexican fruit fly (*Anastrepha ludens*). In the United States, the Mexican fruit fly, then also called “orange fly” or “orange worm,” had been observed as early as the end of nineteenth century in California and shortly after, in 1905, in Texas. U.S. official notices of “Quarantine No. 5, Mexican fruit fly” promulgated in 1913, and “Quarantine No. 56” issued ten years later, prohibited entry to the United States of all Mexican fruits due to threats of the pests (in 1936, the latter, Quarantine No. 56, incorporated the regulations of the former No. 5, which was

[17] VHT and FHAT differ in relative humidity of air for disinfection (i.e., VHT uses saturated or nearly saturated air, whereas in FHAT relative humidity can be as low as 30 percent) and means for transfer of heat (i.e., in VHT heat is transferred by condensed vapor on fruits and convection, whereas FHAT uses only convection) (Hallman and Armstrong 1994; Jacobi, MacRae, and Hetherington 2001).

thereby revoked). In 1927, moreover, citrus orchards in Lower Rio Grande Valley, Texas, were found infested with the fly, resulting in the USDA's rigid domestic quarantine controls of fruits grown there (Comisión Nacional de Sanidad Agropecuaria 1999; Berry 1943).

Early recommendations to prevent the pests included simple and idyllic recommendations such as letting turkeys and chickens eat larvae in orchards (Mangan and Ingle 1994). However, alarmed by the infestation in the Valley, Texas citrus growers and state agricultural officials urged the USDA to establish a research institute in Mexico City in 1928 to investigate *Anastrepha* flies in cooperation with Mexico (Comisión Nacional de Sanidad Agropecuaria 1999; Shaw, Lopez, and Chambers 1970). The partnership between the United States and Mexico was possible because of their growing concern for economic loss caused by the Mexican fruit fly as citrus and mango fruits were under embargo by the United States. The joint research carried out in Mexico contributed to improving control measures against the flies, as illustrated with a decree by the Mexican government in 1934, which detailed instructions to combat the pest in order to protect two states of Sonora and Baja, California (both considered pest-free at that time) from *Anastrepha* species spreading from infested states of Nayarit and Sinaloa (Secretaría de Agricultura y Fomento 1934). The 1945 approval of heat treatment was also an outcome of the research in Mexico (Comisión Nacional de Sanidad Agropecuaria 1999; Secretaría de Agricultura y Fomento 1945).

The ruling to approve the VHT for citrus and mango import to the United States was published in the Federal Register on September 4, 1945 by amending the U.S. Code of Federal Regulations (CFR), Title 7 (Agriculture), Part 319 (Foreign Quarantine

Notices), Section 56 (Subpart – Fruits and Vegetables), known as “Q56,” which today still regulates importation of fruits and vegetable products. The specifics of the approved VHT method, described in the Federal Register (10 FR 12075) were relatively simple: (1) only the Manila variety is eligible; (2) the treatment shall be carried out in a room approved by USDA Bureau of Entomology and Plant Quarantine; (3) treatment should be done under supervision of a USDA inspector; (4) a mixture of heated air and water spray (or other devised means) to give saturation and condensation shall be used; (5) temperature of the center of a fruit shall be raised to 110 degrees Fahrenheit and maintained at that temperature for more than six hours, with a total treatment time for not less than 14 hours; and (6) “those in interest [i.e. those who want to export fruits by this method] must make advance arrangements for supervision of the treatments and the approval of the plant and give acceptable assurance that will provide transportation and per diem for the inspectors” (10 FR 12075).

Although the approval of the VHT was a victory for Mexico, during the years that followed, the export of mangos was quite limited (Table 6-1). Circumstantial evidence I collected suggests a few factors that could explain the scant shipment. According to my interviewees, the Manila, the only mango variety eligible for the export in 1945, is considered less tolerant to heat treatment—a heat-treated Manila is prone to perish quickly. Even today, the export of Manila to the United States is limited because of its alleged shorter shelf life, possibly because of its thin fruit skin. The newer Florida cultivars (i.e., Hayden, Tommy Atkins, Kent, and Keitt), which are more tolerant to heat treatment (Jacobi, MacRae, and Hetherington 2001), were of course not available yet. The then limited freight meant relying mostly on train, which would not allow quick and flexible transportation and might also restrain growth in the Mexican mango export trade. VHT, though it was then the only measure to ensure pest-free mangos, did not allow full access to the U.S. market.

Table 6-1 Import of Mexican mangos to the United States 1944-1961

Fiscal year (July to June)	Volume of imported mangos from Mexico (pounds)		Remarks
	Fresh	Frozen	
1944-45	0	132	
1945-46	0	0	
1946-47	0	0	
1947-48	0	0	
1948-49	-	-	Data missing
1949-50	0	1,204	
1950-51	3	0	Not specified as fresh
1952-53	6,742	700	Frozen includes puree
1953-54	235,392	1,131	
1954-55	422,713	0	
1955-56	602,868	0	
1956-57	697,685	0	
1957-58	824,839	0	
1958-59	450,383	0	
1959-60	392,325	0	
1960-61	322,89	28,474	

Data source: USDA, Office of Foreign Agricultural Relations (1944-1951) and Foreign Agricultural Service (1952-1961), Foreign Agricultural Trade United States Imports of Fruits and Vegetables under Quarantine By Countries of Origin and Ports of Entry

6.3 EDB Fumigation: Real Opening of Export of Mexican Mangos

6.3.1 History of EDB fumigation

Following the years of meager export, however, there was an abrupt increase in the mango shipment after the 1953-54 season as shown in Table 6-1. In 1953, EDB fumigation was approved by the USDA as a new post-harvest treatment for Mexican mangos (Shaw and Lopez 1954). The use of EDB against *Tephritidae* was pioneered by

Balock and Lindgren (1951) and Balock (1951) who demonstrated its effectiveness as a fumigant for treatments of several fresh produces of Hawaii, including avocado, bell pepper, papaya, pineapple, guava, cucumber, and tomato, to kill Mediterranean fly (*Ceratitis capitata*) and Oriental fruit flies (*Dacus dorsalis*) without causing substantial damage (McPhail 1958). This success led to applications to mangos grown in Puerto Rico in 1951 (Richardson 1952) and Mexican mangos in 1953 (Shaw and Lopez 1954), both of which were approved by the USDA as domestic quarantine measure to allow entry of the products to the mainland.

As with the 1945 approval of VHT, the technical and administrative specifications of EDB fumigation were published through a Federal Register (19 FR 2005, April 8, 1954) as an amendment of Q56 (CFR 7 §319.56-2). The instructions, as summarized below, became more detailed than the previous VHT protocol: (1) fumigation shall be done in a chamber approved by USDA; (2) the dosage shall be applied at the rate of 1 pound of EDB per 1,000 cubic feet of space at a minimum temperature of 77 degrees Fahrenheit for two hours after the chamber is filled with the fumigant; (3) Manila mangos shall be put in containers or boxes that give no interference with movement of fumigant gas; (4) boxes or containers loaded in the chamber shall be separated by at least two inches from each other; the chamber shall not be loaded to more than one-third capacity; (5) USDA inspectors shall supervise the fumigation process and prescribe additional safeguard measures, including handling, packing, and transportation; (6) all costs of fumigation equipment and carrying out of safeguard measures shall be borne by the owner of fruits.

The same Federal Register also provided a justification for the introduction of the new treatment: “The newly authorized procedure provides an alternative treatment that may be applied in a much shorter time with less expensive equipment” (19 FR 2005, April 8, 1954). In general, the use of pesticides, including fumigants, has several advantages, such as lower costs, flexibility, and ease of operation, although health and environmental concerns are raised as its major disadvantages (Heather 1994; Yokoyama 1994). With its effectiveness, efficiency, and ease of application, EDB fumigation remained the principal quarantine measure for Mexican mangos destined to the United States from its approval in 1953 until 1987. In this time period, the export of Mexican mangos to the United States increased 422 times from 107 metric tons to 45,140 metric tons. The approval of EDB fumigation marked the real opening of export of Mexican mangos.

Sinaloan growers did not miss the opportunity opened up by the EDB treatment, although they were quite late to engage in mango export. In 1970, more than 15 years after the 1953 approval of EDB fumigation, a grower in Escuinapa, Sinaloa, exported for the first time—he so claimed—EDB treated mangos from the state to the United States. In the interview, this mango grower showed me a letter from the buyer in Los Angeles, California, who purchased the first shipped mangos and was “happy with the transaction,” indicating that the grower’s pioneering attempt of mango export was a success.

Of course, his success was not without labor. With no equipment of his own, to meet the U.S. requirement he had to use a fumigation chamber that belonged to his friend in Sonora (a state located north of Sinaloa) who was treating oranges with EDB. Thus, successful enactment of a PS regulation, which connects non-humans and humans to distant places, is very dependent on local specific circumstances in which needed resources might be unequally available to some actors and completely unavailable to others.

Despite some difficulties, such as the above example, the EDB fumigation approved in 1953 played an essential, if not the key, role to prepare the mango export sector of Mexico to become enrolled in the growing export market (McPhail 1958). Growers in Sinaloa were among those who benefitted most from the growing mango export market. After the pioneering endeavor in the 1970s until the mid-1980s infrastructure for mango export, such as packing facilities and fumigation chambers (Figure 6-1), continued to be strengthened and eventually their share in the nation's total mango export reached 45 percent (Segura 1986). However, cold water was soon thrown on the prospering Mexican and Sinaloan mango sector—in 1983, the EPA announced that the use of EDB would be terminated.

Figure 6-1 Old EDB fumigation chamber (currently used as a general shed) in a mango packinghouse in Escuinapa, Sinaloa, Mexico
(Photo by author)

6.3.2 "Traumatic ban"

On September 28, 1983, the EPA issued a notice (published in Federal Register of October 11) of its intention to cancel the registration of pesticides containing EDB because of its carcinogenic, mutagenic, and adverse reproductive risks (U.S. Environmental Protection Agency 1983). While the ban on the use of EDB as a soil fumigant took an immediate effect (announced by 48 FR 46228), the EPA decided to delay the cancellation of EDB products used for post-harvest fumigation of citrus, tropical fruit, and vegetables until September 1, 1984, "in order to allow time for alternatives for this use to become available on a commercial scale" (48 FR 46234). This phase-out cancellation was premised on the anticipation that alternative quarantine treatments, namely, cold treatment and gamma irradiation, would be available in one year.

Unsurprisingly, however, the USDA opposed the EPA's proposal not only because "citrus and tropical fruits are imported from countries such as Mexico, Haiti, Israel, and Morocco, thereby strengthening our trade position with them" (48 FR 46234), but also because the export of Florida grapefruits to Japan was reliant on EDB fumigation as per Japan's PS requirement. Also, in objecting to the EPA's optimistic anticipation that the alternative treatments would be available soon, the USDA argued that cold treatment was not suitable for fruits other than citrus, and gamma irradiation would not be feasible in such a short time period.

In response, in August 1984 the EPA proposed to establish a temporal tolerance of residues of EDB up to 0.03 parts per million (ppm) in or on mango fruits. The proposed tolerance meant that, while *domestic* EDB use in the United States was banned, mangos treated with EDB *abroad* could be imported to the United States as long as residues in fruits were less than the tolerance level. The EPA also suggested that instead of cold treatment and irradiation, other quarantine measures including HWT and designation of pest free areas in exporting countries could be viable alternatives to disinfect mangos. The proposed rule took effect in January 1985 to remain effective until September 1 and was extended twice until September 1987 when completion of HWT technologies finally came into sight (Table 6-2).

Table 6-2 Process of the withdrawal of EDB fumigation for mango fruits 1983–1988

Date	Event	Federal Register
Oct 11, 1983	EPA announces the intention to cancel the pesticide registration of EDB for post-harvest fumigation of citrus and tropical fruits as of Sep 1, 1984	48 FR 46234
Aug 10, 1984	EPA proposed to establish tolerance of 0.03 ppm for residues of EDB in or on mangos resulting from post-harvest fumigation	49 FR 32088
Jan 17, 1985	EPA establishes the tolerance rule as proposed (effective until Sep 1, 1985)	50 FR 2547
Feb 14, 1986	EPA extends the tolerance rule until Sep 30, 1986	51 FR 5682
Sep 29, 1986	EPA extends the tolerance rule again until Sep 30, 1987	51 FR 34469
Sep 30, 1987	The tolerance rule expired	
Apr 1, 1988	USDA approves HWT as a quarantine treatment for mangos	53 FR 10525

Understandably, the proposed tolerance rule and its extensions drew both opposing and supporting comments from a variety of stakeholders, as summarized in the Federal Registers that promulgated the decisions (50 FR 2547, 51 FR 5682 and 51 FR 34469). Opposition was raised by U.S. mango growers, primarily those in Florida, who condemned the tolerance rule for unfairly favoring foreign mango growers; and consumer, environmental, and other public interest groups were concerned about the hazardous effects of EDB to food safety and public health. Support came from U.S. mango importers, distributers, and retailers, who could continue their mango business thanks to the tolerance, and governments of mango exporting countries including Brazil, Columbia, Haiti, Mexico, and Peru, representing the mango growers and exporters for whom the ban of EDB fumigation was a “traumatic event” (Aluja [1993] 1994:7).

Among those who most fervently supported the tolerance rule was Mexico, the largest mango supplier to the United States, who claimed that if the rule was not established, mango prices in the United States would triple, five to six million dollars of U.S. tax revenues would be lost, and "60,000 Mexican workers would suffer adverse economic consequences" (51 FR 5682). Likewise, the state government of Sinaloa expressed strong support of the tolerance rule, asserting that "mango production requires a year round labor force providing permanent employment for farm families, who would contribute to the migratory problems of US if they were not employed" (51 FR 5682). For Sinaloan mango growers facing the economic menace, even the EPA's "scientific" risk assessment of EDB appeared to be questionable. A leader of CAADES (a state-level organization of private-landowning farmers in Sinaloa) pronounced that the EPA decided to withdraw EDB fumigation because of pressures from political groups "without scientific, reasonable, and proofed evidence that this [EDB] is a carcinogenic product, capable of causing sterility in humans" (Segura 1986:16). In the comments by the governments of Mexico and the state of Sinaloa, it is notable that the risks of the pest (i.e., fruit flies), and of the hazardous substance (i.e., EDB), were almost completely "economized" and "politicized," as it were. As mentioned in the previous chapter, scientifically calculated, or "scientized," risks are prone to be transformed and converted into other types of risks, which cannot be handled by scientists who calculated the risks as such.

Given the magnitude of anticipated economic loss by the ban, growers of export mangos in Sinaloa were in "anguish," according to a local newspaper's editorial (Noroeste, Sep 7, 1985). To cope with the crisis and to seek alternatives to EDB fumigation, CAADES launched *Comité Técnico de Investigación, Fitosanidad y Defensa de Mango* (Technical Committee of Research, Plant-health and Defense of Mango, “Technical Committee”), and along with federal and state government authorities, started a campaign against the fruit fly in 1984 (Anonymous 1986; Segura 1986). The campaign entailed diverse pest-prevention activities, such as monitoring by field traps and sampling of fruits, chemical and cultural-mechanical control, along with technical extension (Anonymous 1986). Research using traps to monitor distributions of the fruit fly pests in the state was also conducted (Huerta Paniagua et al. 1986). Technical Committee and CAADES continued actions to save the mango production of Sinaloa, as frequently reported by local newspapers during 1984 and 1985 (Figure 6-2). For instance, CAADES made a petition to the Mexican government to request that the U.S. government extend the deadline of EDB prohibition (Noroeste, September 6, 1985). They also requested the federal and local governments to take measures to block fruits from regions heavily infested with fruit flies (Noroeste, June 1 and 19, 1984). Although other alternatives such as application of insect hormone and irradiation were sought (Noroeste, September 6, 1985), major efforts were concentrated on two scopes: (1) research and development of HWT, carried out mainly by researchers of USDA-ARS in its research facility in Weslaco, Texas, and (2) establishment of an official campaign against fruit flies in Mexico, including area-wide management strategies to eradicate and/or suppress fruit fly pests.


10-A Regional

Restricciones a exportación de mang

En tres semanas funcionará la guardería IMSS de Mazatlán, albergará a 200 niños

Riguroso plan propuso el Depar de Agricultura de EU a la CAAD

Figure 6-2 A local newspaper article reporting export restrictions caused by EPA's ban on EDB fumigation
Noroeste (Mazatlan, Mexico), June 13, 1984

6.4 HWT: Determining the Social life of Mangos

6.4.1 History of HWT

HWT was applied as early as the late 1800s for disinfection of a variety of plant products; later, in the 1950s to the early 1970s, combined with aqueous solutions of EDB, it was used on fruit flies in mango and papaya (Burditt et al. 1963; Seo et al.1972; Sharp 1994). In search of an alternative to the banned EDB, HWT alone (i.e., without EDB solution) as a quarantine treatment was first investigated in Florida mangos infested with Caribbean fruit fly (*A. suspensa*) in the early 1980s (Sharp and Spalding 1984), then was tested with different varieties of mangos, grown in various places (Australia, Brazil, Guatemala, Haiti, Jamaica, Peru, Venezuela, and so forth) infested with Tephritid species (Jacobi and Giles 1997; Jacobi, MacRae, and Hetherington 2001; Nascimento et al. 1992;

Sharp et al. 1989; Sharp et al. 1989; Sharp 1988; Sharp and Picho-Martinez 1990; Smith and Chin 1991). These experiments were conducted to determine the time-mortality relationship of larvae in fruits (i.e., rate of larvae killed as function of treatment time) to attain Probit 9 (99.9968 percent) mortality level at the 95 percent confidence level (i.e., the treatment should not allow more than 32 insects to survive when 1 million larvae are treated), which has been the most frequently accepted quarantine security level in the United States (Baker 1939; Follett and Neven 2006).

Basic HWT testing processes (Figure 6-3) and its experimental equipment (Figure 6-4) seem relatively simple. Still, the experimentation would demand a researcher's care and patience in handling thousands of tiny organisms. In addition, because importing countries demand slightly different levels of quarantine security, a country wishing to export mangos (and other fruits as well) to a different country may call for alternative evidence that meets its requirements. Different cultivars with varying physical and/or physiological characteristics can present different responses to the pest as well as heat treatment and the following cooling procedure (Follett and Neven 2006; Shellie and Mangan 2002). As described in the previous chapter, the relationship between fruit fly pests and their host plants entails complex and contingent factors. In fact, initially the USDA did not allow importation of mangos grown in Chiapas even if treated with HWT, because a different cultivar Ataulfo was dominant there and this southern state was infested with Mediterranean fruit fly against which HWT had not yet proved effective until another test (Sharp et al. 1989) was carried out.

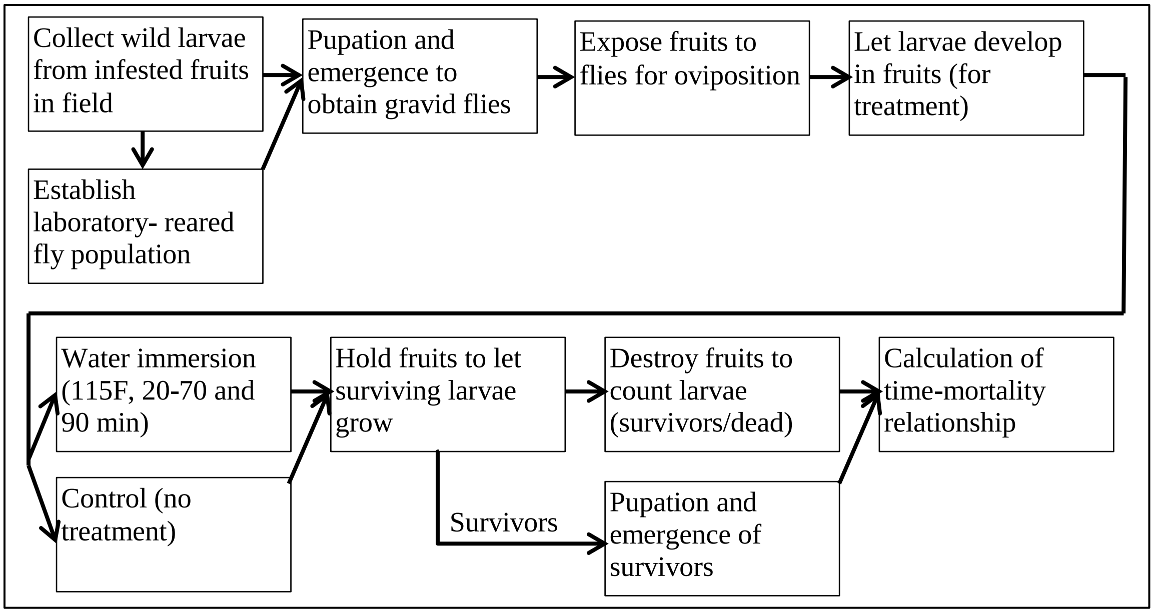

Figure 6-3 Outline of an experimental use of HWT
Elaboration by author based on the description by Sharp et al. (1989)

Figure 6-4 Equipment for HWT experimentation in Metapa, Chiapas, Mexico (Photo by author)

6.4.2 Meticulous and thorough control

On April 1, 1988, Federal Register (53 FR 10525, April 1, 1988) pronounced that HWT was approved thanks to research by USDA-ARS. Unlike the previous cases of VHT and EDB fumigation, the technical and administrative protocol of HWT for the export of Mexican mangos was not published in Federal Register. Instead, the technical and administrative specifications were detailed in Plant Protection and Quarantine Treatment Manual (PPQ Treatment Manual) and Work Plan. PPQ Treatment Manual includes a section that deals exclusively with HWT and "treatment schedules," which specifies parameters, such as water temperature and time duration for different commodities and fruit sizes (USDA-APHIS-PPQ 2010). Meanwhile, the Work Plan is "a formal agreement signed by a representative of each treatment facility in a particular country, the Agriculture Ministry of the host government, and by USDA-APHIS" and "govern[s] the day-to-day operations of each facility and can be improved from one year to the next" (USDA-APHIS-PPQ 2010:3-3-15). Transferring decision-making authority from a "higher" (e.g., Federal Register) to a "lower" order in administrative and organizational hierarchies (e.g., administrative manual) would allow PS officials to introduce detailed technical specifics. Indeed, both PPQ Treatment Manual and Work Plan meticulously stipulate technical and administrative specifics of the disinfection procedure. They are frequently modified as new technical knowledge or administrative needs emerge through "day-to-day operations." The Work Plan, for example, is renewed every year. Administrative procedures are meticulous and thorough. For instance, in contrast to the 1945 VHT instruction's simple requisite of "arrangement for the inspection and . . . acceptable assurance . . . [of] transportation and per diem for the inspectors" (see page **Error! Bookmark not defined.**), the 2009 Work Plan meticulously stipulates USDA treatment technicians' (i.e., inspectors') work duties as follows (USDA-APHIS and SAGARPA-DGSV 2009):

> USDA treatment technicians will be assigned to work Monday through Friday. Working hours will be 10:00 hours to 19:00 hours with 1 hour for lunch. Work performed in excess of 40 hours per week or 8 hours daily, will be reimbursed at 2 times the basic hourly rate, for the first 9 hours, 3.0 times the hour1y rate for all hours worked thereafter . . . . (11)

Moreover, the Work Plan defines in detail responsibilities of participants in this preclearance (i.e., PS measures taken prior to entry to the country) program for export of mangos, including USDA-APHIS, SAGARPA, and EMEX. And, such meticulousness has grown since the first signed Work Plan, indicating that the scope of regulations over operations of HWT has been expanding beyond the packinghouse where the treatment is conducted. For instance, recent Work Plans demand that groves of mango for export be registered prior to harvest and shipment to ensure traceability, although the USDA-APHIS in the first approval of HWT in 1988 did “not believe that tracing fruit back to its origin will be necessary” (FR 53 10526).

Thus, when compared to the administrative instructions for VHT and EDB fumigation (only one to a few pages on Federal Register), the administrative and technical specifics detailed in Work Plan of HWT, especially those of recent versions, have become remarkably meticulous and thorough. Non-humans (e.g., mango fruits) and humans who handle them are disciplined to conform to the specific procedures and physical settings of the treatment, which creates and maintains the distinction between pest and non-pest. Further analysis will be provided later in this chapter where I discuss such disciplining effects by the regulation with more specific examples.

Moreover, it can be inferred that as the rules became meticulous and thorough, financial and technical costs to conform to the regulation increased. As indicated in the Work Plan, burdens for acquiring equipment, coordinating labors, and handling administrative red-tape were basically borne by packers/exporters interested in exporting fruits. The gap between growers and packers who could afford to conform to the rule and those unable to do so would widen, producing a similar asymmetrical consequence in prospects of economic gains. Also, the contrast between those who are controlling the rules and those who abide by them would become stark, and might result in more conflicting confrontations (Chapter 9 will address such conflicting cases).

6.4.3 *Tódologo*'s trial and error to make HWT work

Meanwhile, the 1988 approval of HWT and the concurrent formation of the Work Plan did not mean that mango packers were able to immediately begin shipping fruits to the United States. Certainly, as explained earlier, the PPQ Treatment Manual and Work Plan specified in detail technical parameters of the treatment and administrative procedures. Nonetheless, setting the parameters does not suffice to enact the regulation on site. The regulation has to be "materially" (i.e., as a more concrete physical embodiment) enacted. Designing, constructing, and operating a physical apparatus to meet the specifics at a commercial scale would demand painstaking work.

To document how Sinaloan packers tried to adapt to the new HWT regulation, I conducted formal and informal interviews with more than six individuals in Sinaloa and other places in Mexico. The stories I heard from them, however, varied and seemed fairly blurry perhaps because twenty years had passed since the introduction of HWT. For instance, a grower told me that a dealer from the United States had brought some packers a design of a treatment facility. For another packer, a company in Culiacan, the state capital, designed and constructed the facility. My interviews were unable to reach a single consistent narrative of the process through which HWT was introduced and began its operation in the area.

Yet, I learned that interestingly two different designs of HWT unit, namely, "continuous" (Figure 6-5) and "batch" (Figure 6-6), were developed. In a continuous unit, baskets containing mangos are dipped, *continuously* one by one, in a long hot-water tub (trench) from one end moving toward the other; and fruits are disinfected and move at a constant speed. In a batch unit, a basket is simply immersed until a treatment is finished without moving—since hot water circulates intensely in a tank looking like a hot tub, this design is also called "Jacuzzi." A packinghouse technician suggested that a Culiacan manufacturer of meat processing equipment had come up with the idea of the continuous treatment design based on a hanging conveyer for beef carcasses. Although this company went out of business, the idea survived and was embodied as the continuous system. However, in fact, the continuous type was almost extinct by the time of my fieldwork; out of more than 45 mango packers in Mexico, as of 2009 only one packinghouse in Sinaloa was using a continuous unit (Brazil and Peru did not have this system, according to a USDA inspector). The continuous unit has a disadvantage—if a sensor in even only one basket finds temperature lower than the standard, then all fruits in other baskets in the water disqualify for export. This might be one reason why this design was disappearing.

Figure 6-5 Continuous HWT unit (the last one in Mexico) in Escuinapa, Mexico
A basket, hanging from above (like a gondola lift), moves from this side towards the opposite end in the trench, which will be filled with hot water when in use
(Photo by author)

Figure 6-6 HWT unit, "batch (Jacuzzi)" type
Unlike in the “continuous” type, a basket does not move during treatment but stays in a separate tank. When a treatment is finished, the basket will be hoisted and moved beyond the screen wall (behind the last tank) for packing in Sinaloa, Mexico (Photo by author)

Unfortunately, the limited time for fieldwork did not allow me to determine the origins of these different designs—who developed them and brought them to Sinaloa—or more detailed stories of how one particular type survived while the other was disappearing in Mexico. Still, the personnel of two packers, which were using a continuous unit and a Jacuzzi unit respectively, noted that regardless of the types of unit, the packinghouses had to do everything almost on their own because all that was provided by USDA was a set of parameters of temperature and time. It was very likely that, at least in Sinaloa, to build and operate an HWT unit initially, packers/exporters relied on different resources, including their own experiences and connections to venders or constructors of packing devices. The packer that still uses the continuous unit had to set up, modify, and maintain the equipment by hands of a technician, whom its manager called “*todologo* (utility man, all-rounder),”[18] through “*todo inventando en todo lado* (inventing everything in every aspect).” After initial installation, the HWT equipment kept being upgraded through trial and error based on experiences and skills gained in day-to-day operations. It was through continuous trial and error through mundane operations that the HWT as a technology has gradually become a mature technique, or to borrow an expression by an interviewed USDA official, a “*técnica cubierta* (covered or secure technology).” It is the mundane operations of HWT that continuously establish the distinction between pest/non-pest statuses of the commodity and simultaneously determine the “social life of the thing,” that is, mangos as an export commodity.

6.4.4 Destinies of mangos

The 1945 approval of VHT, which first opened export of Mexican mangos, already specified the Manila as the only eligible variety of mango for export. Mangos *criollos* (diverse local strains that have not been fixed as distinctive commercial varieties) were excluded. They could not be an export commodity. Instead, the PPQ Treatment Manual (as of October 2011) classifies origins, shapes of varieties, and sizes of the commodity with varying dipping treatment durations (Table 6-3).

[18] *Todólogo* is not a common Spanish word but an invented term combining *todo*, which means all or everything, with a suffix -*logo*, which means someone specializing in or being good at something especially in an academic domain. For example, *sociólogo* means sociologist; *entomólogo* means entomologist. A *todólogo* is a person who is good at handling everything.

Table 6-3 Classification of fruits and their dipping time in HWT

Shape of the fruit	Examples of varieties	Weight of the fruit (grams)	Dipping duration (minutes)
Flat, elongated	Frances, Carrot, Zill,	Up to 375	65
	Ataulfo, Carabao, Irwin, and	376 to 570	75
	Manila		
Rounded	Tommy Atkins, Kent,	Up to 500	75
	Hayden, and Keitt	501 to 700	90
		701 to 900	110

Note: These specifics are for mangos grown in Mexico or Central America (north of and including Costa Rica). Different weights and dipping durations are applied to fruits from other origins.
Source: Treatment schedule T-102A, PPQ Treatment Manual (USDA-APHIS 2010:5-2-56-58)

As if it is a rite of passage to become an export commodity (Tanaka and Busch 2003), mangos go through HWT processing. However, not all fruits can qualify for the treatment. The Work Plan for 2009 dictates that a SAGARPA official or personnel of an authorized third-party inspect ripeness of fruits because mangos “not meeting the degree of ripeness will not . . . qualify for treatment for exportation” (USDA-APHIS and SAGARPA-DGSV 2009:6). As per the size classification (Table 6-3), furthermore, fruits over 900 grams are not eligible for the treatment, hence, for the export.[19] Harvested fruits therefore must be pre-sorted by weight classes, using a sorter machine (Figure 6-7). Large mangos are eliminated by an eliminator (Figure 6-8), which is the very passage point that determines whether a fruit can become an export commodity or is forced to stay in the country.

[19] Mangos over 700 grams up to 900 grams were not allowed for import to the US until 2003.

Figure 6-7 Fruit sorter in a packinghouse in Escuinapa, Sinaloa, Mexico (Photo by author)

Figure 6-8 Fruit selector in a packinghouse in Escuinapa, Sinaloa, Mexico
The device is installed before the fruit sorter (Figure 6-7, above). Large mangos that are ineligible for HWT drop into the container.
(Photo by author)

Pre-selected and pre-sorted mangos go through a HWT, which has to be conducted under precise and thorough control, monitored, and with a record of temperature and time parameters. A USDA inspector tolerates no deviance from the standards. Fruits that are treated for "even one minute short" (a USDA inspector) of the requirement are rejected. Or, a failure of monitoring or logging parameters—although a newer model is equipped with an automatic data-recovery program—results in rejection of the treatment and fruits must be re-disinfected from the beginning (but a packer would not do this at least for fresh mangos because of excessive damage caused by heat).

6.4.5 Controlling behaviors of humans and non-humans

Once mangos are successfully treated with hot water, they are moved to a secured holding area to be cooled for packing and shipping. A USDA stamp with a unique number of the treating packinghouse is put on each box as proof of HWT. The holding area, as per the instruction of Work Plan, must be secured at all times to prevent untreated fruits from being mixed with treated fruits. This ruling is so stringent that if a live fruit fly is found in the secured area, all fruits in the area must be rejected.

The stringent control to "secure" a holding area means to control acts or behaviors of humans and non-humans. One of the packinghouses I visited had "double screen-doors" and a buffer space between them, dividing the clean holding/packing area and the (maybe) infested pre-treatment area (Figure 6-9). When the facility is handling mangos, the double doors cannot be left open simultaneously. An employee standing in the buffer space is assigned specifically to control traffic. When someone approaches to cross this area, the assigned personnel opens the first door, lets him/her in, closes the door behind, and then opens the second door. Also, loading boxes from pallets onto a trailer must be done in a secured way; a trailer's rear hatch must be firmly pressed into a loading dock fringed with cushion foams, leaving no gaps (Figure 6-9). A trailer loaded with fruits is sealed with a metal tag with an ID number and the letters "APHIS" (Figure 6-11); the sealed consignment, which will not be opened until it arrives at the U.S. border, is accompanied with certification documents as a transit pass for domestic and U.S. inspection points.

Figure 6-9 Double screen doors in a packinghouse in Escuinapa, Sinaloa, Mexico Both doors are left open in this picture taken during an off-season (Photo by author)

Figure 6-10 A loading dock in a mango packinghouse, Escuinapa, Sinaloa, Mexico Trailer's rear hatch is tightly pressed against sponge-foams of the dock. (Photo by author)

Figure 6-11 Metal tag at Las Brisas inspection point, Sinaloa, Mexico. The tag is proof of sealing a consignment of mangos destined to the US accompanied by a PS certificate document (Photo by author)

6.5 *Irradiation: A New Paradigm?*

As shown above, the HWT has become the most common quarantine measure to enable the export of Mexican mangos. But, as the HWT has several problems, such as damage to treated fruits, efforts to develop options of post-harvest treatments have never ceased. More recently, for instance, variations of temperature treatments and high-pressure processing combined with cold or heat treatment have been tested, although these methods still need improvement to completely kill larvae in fruits (Candelario et al. 2010; Castañón-Rodríguez et al. 2010; Velazquez et al. 2009; Velazquez et al. 2009). Another new post-harvest treatment is the use of irradiation, technically referred to as ionizing radiation. While different irradiation sources exist (Burditt 1994), those commonly used for plant quarantine and approved by USDA-APHIS are electron, gamma rays, and X rays (USDA-APHIS 2010, PPQ Treatment Manual Irradiation). Irradiation is an effective alternative to previous post-harvest measures and for some plant products is the only or the best pest risk mitigation measure; the treatment schedule is designed to attain required quarantine securities without causing major damages to product quality or hazardous effects on food safety (it is a misconception that irradiation makes products radioactive) (USDA-APHIS 2008b; Burditt 1994; Bustos et al 2004; Ferrier 2011; Follett and Neven 2006). Nonetheless, with concerns about adverse effects in food safety, irradiation has been controversial, and costs of the treatment are high compared to other measures (Ferrier 2011; Ten Eyck 2002).

This technology was first approved by USDA-APHIS in the 1990s for use on papaya from Hawaii and in 2002 for other fresh fruits and vegetables from all countries (USDA-APHIS 2010). Yet, it was not until 2006 that irradiation as a quarantine measure was actually applied to fresh produce. In 2011 USDA-APHIS established generic irradiation doses for different pests; since then several fruit commodities including mangos from India, Mexico, Philippines, Thailand, and Pakistan and guava from Mexico have been approved for the treatment, although their imports are still quite limited perhaps due in part to “stigma” associated with irradiation (USDA-APHIS 2008b; Ferrier 2011).

An intriguing consequence of this quarantine method is that unlike the previous EDB fumigation and HWT, which were intended to achieve the immediate mortal effect on fruit flies, such quick killing is not needed. The dose of irradiation to treat fruit fly pests is intended only to prevent larvae from becoming adult flies (although stronger irradiation can cause immediate death to insects, such a high-dose treatment can damage products, too). This means that the U.S. PS officer at the import inspection may find living larvae in mangos treated by irradiation. While a live larva intercepted in mangos treated with hot water results in serious consequences for packers/exporters, including temporal suspension of export certificate and correctional actions, that is not a problem in irradiated mangos as far as the consignment is accompanied with documents verifying that fruits have been exposed to the required dose of irradiation. Hence, “the use of irradiation as a phytosanitary measure presents a new paradigm” (USDA-APHIS 2010:3-8-2) for PS regulations on fresh produce.

Furthermore, what is remarkable about this treatment is that its effects and processes are only indirectly perceivable to humans and instead seem to be increasingly reliant on what ANT scholars might call “inscription devices,” which capture the treatment’s workings, convert, and store them in a form perceivable to humans. Certainly, the previous treatment schemes, such as heat treatment, utilize devices to monitor and record parameters of a treatment (e.g., thermo-sensor and data logger). However, its effectiveness is perceptible by human sensory mechanisms. Water is hot (and EDB smells sweet—but you should not inhale it). When a treatment is completed, its effect becomes visible—maggots should be dead in mangos. Ionized radiation as such cannot—and should not—be directly perceived by us, humans, unless we are willing to be seriously damaged. Irradiation as a quarantine measure does not have to cause immediate effects (i.e. instantaneous mortality). An invisible effect, which is only inscribed on non-human devices, now substitutes for a more direct sign of effect (i.e., dead larvae). Thus, monitoring of the treatment and records of its invisible effects are becoming essential to enable the working of the irradiation treatment as a quarantine measure.

Yet, such reliance on inscription devices and extended monitoring does not pertain exclusively to the irradiation treatment. The extending scope of regulations was already notable even in the protocol of HWT with the intention to meticulously control many aspects of operations not only in a packinghouse but also outside of the facility (e.g., orchard registration required by recent HWT Work Plans). In this sense, it might be inadequate to consider the irradiation a “new paradigm.” As I will discuss in the next chapter, more recent alternative PS regulatory schemes, including pest eradication and establishment of pest-free areas, rely on a spatially and institutionally wide-ranging regulatory network that monitors beyond the loci of production and distribution (Follett and Neven 2006).

6.6 Summary

As posited with the working hypotheses discussed in Chapter 3 (Methodology), the history of post-harvest quarantine treatment to make export of Mexican mangos possible has been a process that engages a variety of entities, including devices and other physical objects as well as human agents. These diverse actors in association constitute the materially heterogeneous network that draws the distinction between pest/non-pest, making possible the export of Mexican mangos. The process of association, however, is also a process of demarcation, classification, and exclusion of certain things. Some mangos (e.g., *criollos* and large mangos, and mangos grown in Chiapas when the HWT protocol took first effect) were disqualified for export to the United States. Some growers and packers/exporters might have managed to find treatment equipment, but others might not have. The destinies of mangos, growers, and packers were thus determined by the regulation and financial and technical ability to abide by the regulation. Some mangos might go to export fresh and others might remain in the country maybe fresh or become mango puree; growers of the export mangos might benefit from the new market opportunity, but others might not.

What PS regulations accomplish is not merely the shaping of the trade of fruits and vegetables. Every aspect of the treatment is under meticulous and thorough control, comprising subcomponents within the network, as predicated with one of the working hypotheses drawing on the evolutionary development of systems. The stringent control measures engender "disciplining" effects over behaviors of non-human things and humans. They act, or are disciplined to act, conforming to norms of a globally extending PS regulation network though in a very local context (e.g., at double-screen doors in a packinghouse). It can be inferred that similar ordering of behaviors is happening in a packinghouse, whether in Mexico or other countries, where post-harvest treatments are employed to export mangos to the United States. USDA-APHIS has been sending its employees to help countries wishing to export mangos establish HWT as a preclearance program. As with the case of Mexico, these countries were required to agree with Work Plans, which dictate operations of the treatment. As Alvarez (2001; 2006) points out, this might be an indication of postcolonial U.S. domination through enactment of its agency over the nation's borders, embodied as "encroachment" of the U.S. border into other countries. While this postcolonial critique seems very plausible since it is the United States that seems to dictate commodity export programs overseas, it is also possible, and reasonable, to comprehend this extending regulation beyond nation-state borders as an outcome of the prevailing science-based, global regulatory governance. Under this governance scheme reigning today's global trades, it seems, even the United States has to conform to specific scientific rulings. Mexico, though at a much smaller scale, was requiring a PS preclearance program on apples in the United States (Ramos, Perera, and Sliter 1999) and similar programs in a few other countries exporting agricultural products to Mexico. In 2004, Mexico banned the importation of California peach and nectarine due to risks of oriental fruit moth (Follett and Neven 2006). In essence, it is the scientific governance scheme that makes possible the apparent "postcolonial" and neoliberal domination by certain countries over others in an era of global trade.

Indeed, one of the highlights of the next two chapters is an observation that the science-based governance is growing as a spatially and institutionally diffusive network of regulation, substituting partially if not completely the post-harvest regulation scheme, whose focus still seems to be concentrated on the process of disinfection. Yet, it is the case that, recently, protocols of post-harvest treatments also entail a broader scope of regulations. Groves must be pre-registered prior to shipment and trailers loaded with treated mangos must be sealed and accompanied with certifications. As illustrated more evidently in the case of the irradiation treatment, some treatment measures employ devices to capture subtle, imperceptible effects to human sensory mechanisms. These observations indicate a trend in the regulatory mechanism, which hinges on stringent monitoring, documenting, and record-keeping to ensure traceability. And, as illuminated in the next chapter, this trend is parallel with the trend of recent alternative PS measures such as PFA, incorporated in the campaign against fruit flies in Mexico.

Chapter 7

Engaging Humans and Non-humans for Control II:

Campaign against Fruit Flies

While the post-harvest treatment examined in Chapter 6 is still a very common measure to control and quarantine mango pests, alternative measures such as the establishment of PFAs, eradication programs, determination of host status (Chapter 5), and systems approaches (integration of more than one risk mitigation measure to achieve cumulative quarantine safety) have also been investigated and are becoming common (IPPC 2007; Follett and Neven 2006). The significance of these alternatives has been growing as the Probit 9 morality, a widely accepted quarantine security level, has come to be deemed not always adequate—insufficient or too stringent—for certain pests and/or commodities (Follett and Neven 2006; Landolt, Chew, and Chambers 1984; Mangan et al. 1997). Another persistent and intrinsic problem of the post-harvest treatment measure is the damage to products, which has prompted the search for alternatives to post-harvest treatments. Moreover, MB, a commonly used fumigant for plant quarantine use, is an ozone-depleting substance. The use of MB is to be terminated or at least drastically limited, resulting in the urgent need to develop alternatives. In short, PS measures that can handle pests flexibly in accordance with differing levels of risk without causing damage to products and the environment are currently being sought (USDA-ARS 1997).

In Mexico, alternative measures to post-harvest schemes for the mango export have been explored and in some cases have generated significant outcomes. In Sinaloa and 21 other states in Mexico (as of 2009), the National Campaign against Fruit Flies ("the Campaign," hereafter) is in operation to eradicate or suppress fruit fly pests in some areas for recognition or protection of PFAs and areas of low pest prevalence (ALPP). Some municipalities in northwestern states (Baja California Sur, Sinaloa, and Sonora) have been recognized as fruit-fly-free. Once an importing country officially recognizes an area as pest-free, mangos and other fruits grown there, even if they are hosts of the pest, can be exported without additional treatment. The Campaign employs a variety of PS measures, including legal and technical activities, as alternatives to the post-harvest treatment. As will be demonstrated in this chapter, regulatory activities of the Campaign, in comparison to the post-harvest treatment, extend far beyond a packinghouse, extending even to non-farming areas and those who are not involved in mango production. The regulatory network stretches out not only spatially, but also institutionally and organizationally, involving diverse organizations and individuals and non-human beings (e.g., machines and organisms).

This chapter will focus its analysis on how these outspreading PS regulatory activities have developed. While post-harvest treatments have been enabling the growing mango export from Mexico for about 60 years, incessant research efforts have expanded understanding of the biology of fruit flies, resulting in the massive national program to control the pest in the field. The Campaign's activities include day-to-day mundane, and even quite boring practices, but it is such tedious and recurrent practices that continually enact distinctions between pest and non-pest. Also, the Campaign employs on different occasions something similar to what Latour and Woolger ([1979] 1986) call "inscription devices," or "apparatus or particular configuration of such items which can transform material substances into a figure or diagram which is directly usable" (51). For instance, a set of apparatuses used for bioassay[20] that provides written output to be used for further arguments by scientists can be considered an inscription device. In this regard, as described in the previous chapter, inscription devices played important roles in the post-harvest treatment scheme (e.g., thermo-censer, dosimeter, and data logger). In the Campaign too, certain devices, including traps to capture fruit flies, function in a similar and critically important manner, that is, they convert something that is not perceptible or directly observable to humans into visible formats (e.g., number of captured fruit flies).

From ANT's perspective, this process could be called "translation," through which actors in a chain transform artifacts and build and extend networks (Callon 1986; Latour 1986). Phenomena observed in the field are converted into written format, including tables or diagrams. These inscribed records are continuously processed by different human and non-human actors, and eventually accumulated as data, which then become the basis for an "empirical" and "scientific" judgment of whether the pest exists in an area. The judgment of the existence of the pest, whether in paper or electronic format, is easily distributed, transcending space and time, and translated further in different domains of society. From the Luhmannian system theoretical perspective (Nagaoka 2006), furthermore, critical attention would be placed upon specific operations of actors involved in the translation processes, which block simple "transmission" of knowledge and conceal complexities or uncertainties. In processing the "scientific" judgment, other social domains such as a government are very unlikely to and almost never doubt the validity of such an "expert" judgment. As demonstrated in chapter 5, this can lead to a situation where the scientific community could shy away from making an

[20] A bioassay is a measurement using a living organism of a substance or its effects.

administrative decision over whether a specific risk-mitigating measure should be taken and stick to its role as the provider of “objective” bases for decision-making. Indeed, Risk Analysis, which has become the dominant framework of risk governance, divides scientific (hence “objective”) risk *assessment*, and, risk *management* as an administrative process (and risk *communication* as a process to inform stakeholders) (Yamada 2004).

Given the above conceptual lineament, the sections that follow will provide an overview of how some of the major components of the Campaign operated in the field. Specific attention will be paid to ways invisible events or phenomena supposedly taking place in the “natural” field are inscribed and thereby secured as meaningful records to be circulated for further processing in society. This is a process through which uncertainties and complexities in the field are converted into seemingly secure, objective, and plausible knowledge of whether a geographic area is pest-free or not (i.e., pest status of the area). That said, however, the purpose of this research is not to assert that scientific practices and resultant administrative determinations of the pest status are invalid. My analysis is not to cast a doubt on *whether* the pest free status of a geographic region is valid, but rather will revolve around a simple question: *how* is the making and maintaining of the pest-free status of a vast geographical area, which seems almost impossible, made possible?

In what follows, I will first provide a historical overview of the research and development of major components of the Campaign as an area-wide integrated pest management (AW-IPM) system. Then, I will delineate how the major components of the current Campaign operate in the field. The chapter will conclude with a summary of important themes elicited from the findings, including notable characteristics of the

Campaign as AW-IPM, its scope extending to non-farming areas and populations, and its "disciplining" effects that make the behaviors of humans and non-humans conform to global PS regulations.

7.1 Research and Development toward Area-wide IPM against Fruit Flies

Efforts to develop area-wide pest control programs, that is, PS measures to control pests in the field (rather than solely in packinghouses) have a long history in Mexico. Investigations of pests of important crops, such as mango, citrus, wheat, and cotton, have been undertaken since the beginning of the last century. Among them, the battle against fruit flies was probably the most important, the most actively discussed, and the most challenging issue. For example, *Fitófilo*, the bulletin of the Mexican PS authority (currently, SAGARPA-DGSV) published since 1942 (suspended in 1946, resumed in 1951, and terminated in 2000), featured Mexican fruit fly as the bulletin's emblem on its cover page during several years following the resumption of publication (1951), indicating the gravity of concern the PS authorities had about this pest at that time (Figure 7-1).

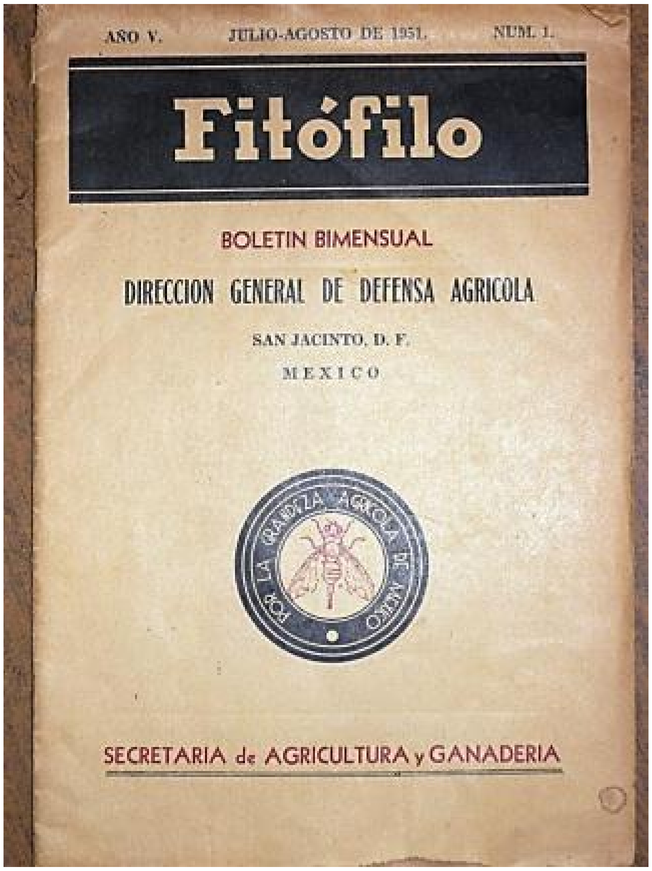

Figure 7-1 Emblem of a governmental bulletin Fitófilo, featuring Mexican fruit fly This bulletin is a copy of the first resumed issue published in 1951.

Before VHT was approved in 1945, with no methods to disinfect harvested fruits available, the control of fruit flies basically meant to eliminate the pest *in the field* rather than *in packinghouses*. Since fruit flies are highly mobile and can take advantage of diverse wild hosts, getting rid of the pest temporarily from a single grove would not suffice. Efforts to achieve or maintain area-wide pest-free status were needed. Thus, in as early as 1934, the Mexican federal government proclaimed the *Cuarentena Interior No. 4, Contra la Mosca de la Fruta en la Zona de Defensa del Noroeste* (Domestic Quarantine Regulation No. 4, Contra the Fruit Fly in the Northwestern Protection Zone), which was intended to protect the states of Sonora and Baja California, then considered fruit-fly-free, from invasion of the pest from other southern states (Secretaría de Agricultura y Fomento 1934).

Collaboration through the joint research program with the United States (see Chapter 6) also encouraged Mexico's venture to combat the pest. U.S. researchers first introduced non-native natural enemies from Hawaii to Mexico for testing in 1954 (Jiménez Jiménez 1956; Jiménez Jiménez and Smith 1958). Another important reason for U.S. involvement in fruit fly control programs in Mexico was an incident in 1955 in Costa Rica. One of the worst, or maybe *the* worst agricultural pest, Mediterranean fruit flies, were detected and began spreading to other Central American countries (Anonymous 1955). In 1955, the U.S. government started to collaborate with Mexico to prevent pest introduction from the border with Guatemala and Belize, in fear that once the pest entered Mexico it would quickly reach the U.S. border. Mexico and the United States established preventative measures throughout the southeast states of Mexico including Chiapas, Quintana Roo, Yucatan, Campeche, and Veracruz. This consisted of a "*cordón* (cordon)" to block the pest (Comisión Nacional de Sanidad Agropecuaria 1999). Activities within the quarantined cordon included border inspection of traffic, liberation of natural enemies, and monitoring of the pest by traps (Ríos Martínez 1961), which are principal activities practiced in today's Campaign. As will be explained later, the idea of the cordon is still active and plays an important role in keeping vigilance over the nation's PS conditions.

Research and development did not cease even after the VHT and EDB treatments protocols were approved in 1945 and 1953 respectively. The Mexican PS authority and researchers continued to explore technologies to suppress or eliminate fruit flies of both

Anastrepha species and Mediterranean fruit fly in the field, not solely in a packinghouse. Articles featuring fruit flies as the topic of research and development for the PS regulatory administration constantly appeared in *Fitófilo* as well as other Mexican academic journals in entomology. To grasp general trends of research and development in the area of fruit fly control in Mexico, I conducted a simple content analysis of articles (the methodology of which is described in the following paragraph) using *Fitófilo* and *Folia Entomologica Mexicana*, the non-regular journal of *Sociedad Mexicana de Entomología* (Mexican Society of Entomology). The presumption underlying the content analysis of these journals was that the former, *Fitófilo*, as an official publication of the *Dirección General de Defensa Agrícola*, the then national PS authority, would present the most imminent issues concerning fruit flies facing the nation's agriculture and the most appealing advancements to tackle them. I anticipated the latter, *Folia Entomologica Mexicana*, would present the then up-to-date original research articles. This journal also occasionally doubled as conference proceedings of the society's meetings, containing titles and abstracts of presentations. Publications of these journals have not been constant. *Fitófilo* in particular went through major suspension periods. Still, their contents were expected to be relevant, if not thorough, indicators of trends of investigations on fruit flies in the field of Mexican entomology, especially in the area of regulatory-oriented research and development.

At five libraries in Mexico (see Chapter 3), I manually reviewed all available issues of the two journals, and photocopied or scanned titles, abstracts, and/or articles that dealt with, even if only partially, fruit flies of major importance for Mexico, including *Anastrepha spp*, Apple maggot (*Rhagoletis pomonella)*, Papaya fruit fly (*Toxotripana* *curivicauda*), and Mediterranean fruit fly (*Ceratitis capitata*). For *Fitófilo*, 82 out of 92 issues published from 1951 through 2000 were included in the analysis; for *Folia Entomologica Mexicana*, 108 out of 110 issues published from 1961 through 2000 were analyzed (note that this journal is still being published and includes some “combined” issues; therefore, the number of volumes I checked was less than 108). The missing issues (10 of *Fitófilo* and two of *Folia Entomologica Mexicana*) were lost or not available at any library. Thirty-nine (39) articles mentioned fruit flies in *Fitófilo*; 72 in *Folia entomologica Mexicana*. The main themes of the articles are identified, categorized, and summarized in Table 7-1 and Table 7-2. The categories of the themes include basic biological knowledge about fruit flies (e.g., taxonomy, physiology, population, and migration in the field, reproductive behavior, dietary habits, or host preference), biological control (search and evaluation of natural enemies of fruit flies), technologies relevant to Sterile Insect Technique (SIT), trapping, and attractants (i.e., substances that attract wild insects to trap), chemical control, regulatory activities (e.g., cordon and pest control campaign), and, especially in *Fitófilo*, presentation of fruit-fly-related information in other countries, including the United States.

Table 7-1 Articles related to fruit flies that appeared in *Fitófilo*, a governmental bulletin on PS administration, 1951-2000

Years	Number of published issues	Number of articles related to fruit fly pests and categories of their topics								Remarks
		Anastrepha fruit fly					Mediterranean fruit fly	Regulatory administration	Other information	
		Biology	Biological control	Sterile insect technique	Attractant	Post-harvest treatment				
1951-60	28		4			1	2			1 issue missing
1961-70	37		6	1	1		4	6	6	3 issues missing
1971-80	18	1						1		6 issues missing
1981-90	3								1	
1991-2000	6						1	3	1	
Total	92	1	10	1	1	1	7	10	8	

Note: The bulletin went through three major suspension periods: 1953–54; 1982–93; 1996–98. In addition, numbers of issues published annually considerably varied among years. Ten issues were not available in the four libraries where I conducted archival research during my fieldwork in Mexico.

Table 7-2 Articles related to fruit flies that appeared in *Folia Entomologica Mexicana*, a bulletin of *Sociedad Mexicana de Entomología* (Mexican Society of Entomology), 1961-2000

Years	Number of issues	Number of articles related to fruit fly pests and categories of their topics								Remarks
		Anastrepha fruit fly						Mediterranean fruit fly	Other information	
		Biology	Biological control	SIT	Trap, attractant, bait-spray	Chemical control	Post-harvest treatment			
1961-70	22	2	0	1	2	0	2	1	0	2 missing issues
1971-80	24	11	0	4	12	2	0	5	4	
1981-90	34	2	2	5	0	2	0	6	0	
1991-2000	30	4	0	0	0	1	1	1	2	
Total	110	19	2	10	14	5	3	13	6	

Note: The journal has been published since 1961. The number of issues published annually considerably varied among years. As some issues were published as "combined issues," the total number of the volumes I examined was less than 110. Two issues were not available in the libraries in Mexico where I conducted archival research.

Understandably, various articles in the two journals focused on Mediterranean fruit fly, which became a chief concern for the Mexican and U.S. PS authorities. *Fitófilo*'s earlier articles (during the 1960s), in particular, included the regulatory administration presenting activities of the abovementioned cordon intended to block Mediterranean fruit flies. Despite these efforts, however, in 1977 the pest was found in Mexican territory. This occurrence led to the launch of a multi-national (i.e., Mexico, the United States, and Guatemala), multi-organizational (i.e., Food and Agriculture Organization (FAO) and International Atomic Energy Agency (IAEA)) pest eradication project, "Moscamed." The project entailed the construction of a mass-rearing plant for sterile flies in Metapa de Dominguez, a township near Tapachula city, Chiapas, Mexico, in 1979 (Comisión Nacional de Sanidad Agropecuaria 1999).

A notable research agenda from the 1950s through the 1970s was a focus on biological control measures against *Anastrepha* flies, including the use of natural enemies (Arrieta M and Coronado Padilla 1968; Cons Duarte, Patton, and Trujillo García 1966; Jiménez Jiménez 1956; Jiménez Jiménez and Smith 1958). The use of natural enemies was of particular interest for the Mexican PS administration at this time as they were expected to self-sustain in the field if introduced appropriately and hence were considered more cost-effective than pesticides (Comisión Nacional de Sanidad Agropecuaria 1999; Jiménez Jiménez and Smith 1958). More recently, biological control has increased in importance because of the growing interest in practicing sustainable agriculture (Montoya and Cancino 2004).

In the more research-oriented journal, *Folia Entomologica Mexicana*, the major research agendas included fruit flies' biology (19 out of 72 articles in Table 7-2) and effective trapping and attractants (14 out of 72 articles). Technical knowledge is essential since IPM necessitates deep ecological understanding of the pest, including the behavior, physiology, and relationship with plants or other insects, to acquire an accurate estimation of the wild pest population. SIT is another noteworthy topic of research and development, discussed in 10 out of the 72 articles (Table 7-2). The first release test of chemically sterilized fruit flies was conducted in a citrus orchard near Mexico City in 1961 under continuous cooperation with the United States and the technology proved very promising. This cooperation led to mass-rearing of three to five million sterile Mexican fruit flies to release in northwestern states bordering with the United States (Comisión Nacional de Sanidad Agropecuaria 1999; Parker 1968). The research on SIT in Mexico sought very specific technical improvements for effective and efficient mass-rearing of sterile flies, which was a critically important component of SIT. For instance, as sterilization affects male flies' competitiveness in reproductive activities, it is necessary to ensure that male flies have sexual capability to actively seek a female and successfully copulate (Calkins 1984; Delgado García and Enkerlin 1973; Esther González and Enkerlin 1975; Hendrichs 1982). Another important agenda is selective mass-rearing for male immature insects (Lozoya S and Aranda H. 1981). In SIT, it is sterile male flies—not vice versa—that can effectively hinder the reproductive process of a wild fly population; sterile female flies are not needed for release (Willhoeft, Franz, and Mclnnis 1994). Although it is desirable to raise only male flies for cost efficiency, in reality both sexes of *Anastrepha* are still reared together even today because there is no effective method for sexual selection at immature stages.[21] Other unique and finical yet important

[21] In production of sterile Mediterranean fruit flies, selective mass-rearing techniques

aspects of SIT were also reported, including: control of quality (i.e., the competence to find female flies and mate with them in the field) of reared flies; methods to mark sterilization-treated flies (because sterilized flies released in the field and captured by traps must be distinguished from wild flies); and tolerance of insects to anoxia (because irradiation under high concentration of oxygen can worsen the quality of treated insects) (Antonio and Enkerlin S. 1982; Chambers 1978; McFadden 1964).

In the meantime, there were surprisingly few articles that explored post-harvest treatments, even during the 1980s when alternatives to EDB fumigation treatment were desperately sought. As noted in the previous chapter, studies on HWT for mangos were led mainly by U.S. researchers, especially those belonging to USDA-ARS, who had previous experience with research on disinfection of commodities from Hawaii. In the meantime, in Mexico, studies on post-harvest treatments as such were rare with few exceptions to complement ARS's work conducted in Chiapas (Enkerlin 1989). The research funding by the Mexican government for HWT studies seemed to be limited as well (Acuña Martínez 1987). In recent years, studies dealing with post-harvest treatment in Mexico have tended to focus on its effects on quality parameters of the fruit and have been reported in horticultural science journals (e.g., Luna Esquivel et al. 2006; Osuna Garcia et al. 2002; Zamora Cienfuegos et al. 2004). These studies undertaken by food scientists or horticulturalists seem to take the post-harvest treatment for granted as a prerequisite for marketization. Mexican entomologists, meanwhile, have been making consistent efforts to deepen understanding of diverse yet essential aspects of native fruit flies, which laid the groundwork for the development of the Campaign against fruit flies

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using genetic sexing strains have been developed and successfully applied to produce male flies exclusively (Zepeda-Cisneros, Cristina Silvia. 2005).

as AW-IPM. In addition to the aforementioned journals, diverse works to extend the understanding of bio-ecological aspects of fruit flies, especially of *Anastrepha* species, were reported in various venues in Mexico (Liedo F. and Bravo M. 1991; Wolfenbarger and Bravo M. 1989). The *Instituto Nacional de Investigaciones Forestales y Agropecuarias* (INIFAP, National Institute of Forest, Agriculture and Livestock Research) also conducted extensive studies of the biology and control of *Anastrepha* species for mangos in eight major mango-producing states (SARH-INIFAP 1987). Outcomes of this research became the basis for the Campaign as a scientific-technical governance project. The agenda of research and development entailed a variety of programs, for instance, the population dynamics and behavior of flies in the field, as well as the trapping, the SIT, biological control using natural enemies, the technology for mass-rearing of sterile insects and natural enemies, and other control measures including chemical and mechanical-cultural. Also, legal-administrative measures, such as the cordon, were established. The diversity of the technical and legal bases for establishing the Campaign signaled the magnitude and the complexity of the pest control program to be launched, which would grow far beyond the site of production, packing, or distribution of fruits.

The steady research effort in Mexico to investigate fruit flies, especially the important native *Anastrepha* species, began proving its significance in the 1980s. This was the exact time period when the traditional EDB fumigation was terminated by the EPA and alternatives were desperately sought. In a sense, it was the EDB ban that prompted the full-fledged endeavor to move from decades-old, stagnant control measures against *Anastrepha* fruit flies toward AW-IPM (Aluja [1993] 1994). The foreign-developed HWT then became the de-facto principal quarantine measure to allow the export of Mexican mangos since 1988. After the EPA's announcement of the EDB cancellation in 1983, the Mexican federal government promulgated, based on "public interest," a decree intended for preventative and combative measures against fruit fly pests (SARH 1985). In 1984, Sinaloan mango growers with CAADES membership, with the support of the Mexican federal and state government, started a campaign against fruit flies (see Chapter 6). This campaign introduced concepts of IPM, primarily consisting of preventive measures including trapping, fumigation, and elimination of indigenous host plants (Anonymous 1986). It was a significant outcome of the rigorous research on wild fly population that 10 municipalities in Sonora were officially recognized as fruit-fly-free by USDA-APHIS in 1988; apples, peaches, and citrus fruits grown there qualified for export without post-harvest treatment (Comisión Nacional de Sanidad Agropecuaria 1999) (53FR50508). Furthermore, technical insights gained through the *Moscamed* project and the previous release of sterile *Anastrepha* flies resulted in a nation-wide control program using the promising SIT. In 1992, the Mexican government launched the *Campaña Nacional contra las Moscas de la Fruta* (National Campaign against Fruit Flies). Right next to the *Moscamed* mass-rearing plant, a new plant, "*Moscafrut*," was constructed with the weekly capacity to rear 300 million sterile pupae of Mexican fruit fly (*A. ludens*) and West Indian fruit fly (*A. obiqua*) in addition to 50 million *Diachasmimorpha longicaudata*, a parasitoid wasp of fruit flies.

After the passing of the current Mexican plant protection law in 1994, the legal framework of the Campaign was also reinforced. The campaign was underpinned with a newly standardized national governmental decree, *Norma Oficial Mexicana* (NOM, Official Mexican Standards/Regulation), *NOM-023-FITO-1995 Por la que se establece la Campaña Nacional contra Moscas de la Fruta* ([the rule] by which the National Campaign against Fruit Flies was established) with the aim of establishing PFA and ALPP. In 1997, another decree, *NOM-075-FITO-1997 Por la que se establecen los requisitos y especificaciones fitosanitarias para la movilización de frutos hospederos de moscas de la fruta* ([the rule] by which the requirements and phytosanitary specifications for the transport of host fruits of fruit flies are established) was promulgated to protect the established PFAs and ALPPs. I will henceforth call the operations of both statutes "the Campaign," because these two regulations combined (and a few other related statutes that determine specifics) function as AW-IPM to establish and maintain pest-free or low-prevalence status, although, technically, only the former (NOM-023) was decreed as its legal basis. Since the promulgation, the Campaign has successfully achieved eradication of the pests in northern and central municipalities of Sinaloa as well as some areas in other states. The next section will delineate current operations of the Campaign through examining the essential components of these two regulations.

7.2 Operations of the Campaign

Now that I have reviewed the historical development of research and development to establish the Campaign, this section will present contents of the Campaign, beginning with an overview of two principal statutes, NOM-023 and NOM-075, followed by descriptions of field operations based on these statutes. My accounts will demonstrate the way the Campaign's operations extended their reach of disciplining effects beyond sites of mango production, involving people with no direct connection to the mango sector. PS regulations added thorough regulatory procedures (i.e., subcomponents) to deal with more diverse actors and entities in different sites. The Campaign thus came to put them into socio-material orderings, revolving around the distinction between pest/non-pest, and simultaneously disciplining them to conform to the commands of the global regulations. Although it is not my intention to present all of the specifics of the Campaign, I will provide somewhat detailed descriptions of the major components of the Campaign. Doing so will persuasively demonstrate the extensiveness and complexity of the Campaign and its particular mechanisms including monitoring, record-keeping, or use of non-human devices.

7.2.1 Overview of NOM-023 and NOM-075

First, NOM-023 (see Appendix 3-1) specifies areas of regulatory actions, mandates subjects of control (fruit fly pests and fruit that are hosts for the pests, or "host fruits"), and stipulates the specifics of the administration and organization. This statute also specifies the field operation of the Campaign, including monitoring of the pest, control measures, standards for recognition of pest-prevalence status, along with more detailed manuals as technical appendices. NOM-075 (see Appendix 3-2) specifies pests and host fruits subject to the regulation and conditions of transport of the host fruits between areas of different pest prevalence statuses. Both NOMs clearly pronounce that failure to comply with the rules will result in sanction, indicating that they are mandatory. Besides these two NOMs, a few other supplemental regulations, including NOM-069-FITO-1995, which specifies procedures to establish and recognize PFA, were promulgated; and NOM-069 is in accordance with standards elaborated by international regulatory bodies such as IPPC and NAPPO. Also, technical and administrative details of the Campaign specified in technical appendices to NOM-023 and relevant technical manuals prepared by SAGARPA also have incorporated international technical standards and recommendations elaborated by IPPC, NAPPO, FAO, and IAEA. These examples clearly indicate that technical and administrative specifics of the PS regulations have been increasing "harmonization" with international trade rules.[22]

Meanwhile, insights accumulated through the incessant research in Mexico about the biology of fruit flies were also incorporated into the NOMs. NOM-023's article 4.9.4 ("Of cultural and mechanical control") commands that all unharvested fruits in an orchard be incinerated or buried in soil deeper than 20 centimeters because it was known that adult flies emerging from pupae buried under this depth cannot escape from the ground. As demonstrated with this example, it is also notable that technical specifics of these NOMs are quite detailed. NOM-075, for instance, in stipulating the procedure for testing sampled fruits (article 4.3.1), requires that a sampled fruit be cut into slices of less than one centimeter thick so that a living larva, if existing in it, can be observed. In what follows, I will present some details of the field operations to control acts of humans and non-humans in accordance with the commands of the two statutes.

7.2.2 Detecting and monitoring the pest

The first critically important element of the Campaign is the detection and monitoring of the pest. An IPM intends to apply necessary measures based on information about pest existence rather than a rigid schedule of uniform applications of control measures such as spraying pesticide. Thus, obtaining knowledge about the

[22] In fact, the original NOM-023 and NOM-075 contained clauses that declare that the statutes as such were not, at the points of their promulgation at least, in accordance with any specific international standards (perhaps because international standards specifically corresponding to these national rulings were not then available). Nonetheless, this fact does not mean that these NOMs were *against* then available international standards.

existence of a target insect through intensive and incessant monitoring is the most important element in enacting IPM. For detection of *Anastrepha* fruit flies, the McPhail trap with a solution of hydrolyzed protein as attractant (Figure 7-3) has been the most commonly used since the 1940s or earlier (Comisión Nacional de Sanidad Agropecuaria 1999; Aluja 1999; Díaz-fleischer et al. 2009).

The Campaign also never stops its operations to detect fruit flies by trapping using McPhail traps. Numerous traps containing material attracting fruit flies are installed throughout monitored regions, whether commercial production areas or non-commercial farming areas, such as urban and wilderness zones, to construct a web of trapping in the entire region. Methods and density (i.e., number of traps to be installed in a certain area) of the trapping are specified in NOM-023. The trap density varies depending on pest prevalence level, season, and characteristics of areas (e.g., whether agricultural production areas, wild forest, or urban residential areas). Each trap is checked weekly to see if a target pest is captured. The exact locations of all the installed traps are identified with a GPS device and recorded in a nation-wide database.

Figure 7-2 McPhail trap on a mango tree for the Campaign in Sinaloa, Mexico
The glass pot, with the opening at the bottom center to allow flies to enter the inside, contains attractant substance. (Photo by author)

Figure 7-3 Inspection of insects in a McPhail trap by a CESAVESIN technician in Sinaloa, Mexico
(Photo by author)

In Sinaloa, CESAVESIN is responsible for the operation of trapping. Its technical personnel who manage the traps are called *tramperos* (trappers in English). Each trapper is assigned a certain geographic area in the state and establishes trapping routes along which traps (forty to fifty, depending on conditions of the areas) are installed. Generally, one trapper is responsible for four to six routes, checks one route a day, and inspects all the trapping routes in a week, and repeats this cycle. Trapping routes are to be modified seasonally and/or depending on phenological conditions of plants.

A trapper, arriving at a trap site, unloads a trap from a tree that is a potential host plant and inspects the liquid inside containing carcasses of insects (Figure 7-2). When completing inspection of a trap, the trapper washes the inside of the trap, pours attractant liquid, and hangs it back on the tree. The trapper makes a record of every trap in an established format. When a *Tephritidae* fruit fly (including those not subject to the regulation) is found, the trapper must keep it in a small plastic bottle filled with alcohol and report it to the office.

Despite the common usage of the McPhail trap as the detection device, its effectiveness to capture wild fruits flies has been subject to debate (Aluja 1999; Díaz-fleischer et al. 2009). In general, according to an interviewed U.S. entomologist, about one percent of fruit flies of a wild population in the field are supposedly captured by the McPhail trap. The effect of the McPhail trap using hydrolyzed protein is biased toward attracting more female flies and can be less effective under conditions of high humidity (Díaz-fleischer et al. 2009). Aluja et al. (1989) reported that almost 70 percent of fruit flies visiting a McPhail trap escaped. In an interview, another Mexican entomologist (specializing in insect population dynamics) who had been involved in a study of fruit flies expressed his bewilderment on the topic of whether or how population dynamics of highly mobile wild flies is accurately captured by traps, in comparison with his experiences with other less mobile insects whose movements can be observed under a more controlled environment. Besides its effectiveness, trapping using the McPhail has other drawbacks such as the fragility of the glass bottle, cumbersomeness of setting, and potential killing of other insects including beneficial ones (Díaz-fleischer et al. 2009). Thus, from the perspective of entomologists, it is certainly necessary to continue improving the effectiveness of trapping, including development of a better attractant.

My point, however, is not to cast doubt upon or object to the use of the McPhail trap for monitoring. Rather, it seems that the central question of the effectiveness of the trapping revolves around how phenomena that are not directly observed by humans can be converted through a particular device (i.e., the trap) into secure and plausible knowledge of pest-free status. Except specific situations (e.g., research to examine effectiveness of the trap such as Aluja et al. (1989)), the working of a McPhail trap and responses of fruit flies attracted to it are not directly visible to human eyes. The trap converts this invisibility into a visible format that makes sense (i.e., meaning). In ANT, such a device that converts invisible phenomena into visible information is called an "inscription device." Through the trap as an inscription device, phenomena in the "natural" field are translated into a domain of meaning, that is, society. In this specific case of the trapping, the uncertainty of the pest (e.g., its behavior in the field) is converted into a simplified distinction: whether the pest is trapped or not (note, however, a trap with no flies does not necessarily, *in the strictest sense,* indicate that there is no fly in the field).

Of course, a simple distinction of whether or not a fly is captured in a trap does not immediately result in a more secure knowledge of whether the pest exists or not in an area. *In the strictest sense,* even if no flies are trapped by all traps installed in a geographic area, whether a fly exists in the area cannot be known. There is no guarantee that the number of insects captured in traps in the area proportionally reflects the real number of fruit flies. Hence, repeated practices of inspection using numerous traps are needed to convert the uncertainty of invisibles into something certain and to conceal the uncertainty of invisible wild flies to allow us to *plausibly assume* that there is no pest in the field. The more repeated the practice is, the less likely or possible to cast doubt upon the assumption. As the practices are repeated and records are accumulated, the assumption eventually becomes secure “knowledge” of pest-free status of the geographic area. Then, we now “know” that there is no pest in the area. Meanwhile, the debate over the effectiveness of the trapping is basically a scientific one. Yet, when the knowledge of “pest-free” status is secured through repeated practices, it can become like a black box, of which plausibility is rarely asked, and which can be “fed” from the scientific domain to other networks, including legal statutes, which can legitimately dictate and command acts of humans and non-humans.

Another important feature of this monitoring by traps is that the monitoring itself is monitored for control of quality of the trapping. Supervisors of the trappers (CESAVESIN, as per direction of SAGARPA-DGSV) or USDA-APHIS officials (only in the northern PFA in Sinaloa) occasionally, without notice, visit a route where a trapper is not present, and put a dead fruit fly in a trap to mock a capture. The supervisors take a record of the trap location and wait for the trapper responsible for the trap, without being notified, to report it in the earliest occasion. Since all the trappers are aware that a "mock" detection may be set up, they would (or at least are expected to) report a detected fruit fly (even if it is a "real" detection) without making an unnecessary judgment over its significance (e.g., the detection might lead to devastating impacts on the mango export industry). Such "nested" monitoring for "quality control" of acts of humans is essential to secure the boundary of pest-free.

According to CESAVESIN personnel (trappers and supervisors) that I interviewed, a few trappers had indeed failed to report a simulated detection. The personnel who failed the test were not punished in any way but called to the office and asked to inspect traps with more caution. Although the interviewees did not explicitly mention it, it could be reasonably imagined that repeated failures would lead to a harsher punishment. By making and keeping the personnel aware of such a possibility, the nested monitoring would continue to exercise its capability to "discipline" them in accordance with global PS regulations—I make the case that this is a global measure since securing quality control measures in monitoring is included in International and Regional (i.e., North America) Standards for Phytosanitary Measures (ISPM and RSPM).

This nested monitoring would remind those who are familiar with Michel Foucault's observations on a specific design of prison, Panopticon, to self-discipline inmates by having them feel under perpetual—whether or not perpetual in fact—monitoring, and its extended form, the surveillance society, which spreads from the prison to every locus of modern society, illustrated with conspicuously installed surveillance cameras—whether or not surveying in fact—making us feel constantly observed and monitored (Foucault 1977). As mentioned in the review of literature in

Chapter 2, the use of such rational means to control human behaviors could be comprehended as a reflection of governmentality, especially that of a neoliberal era where the conduct of an individual is conducted through self-disciplining political technologies for more efficient control (Dean 2010).

The sampling of host fruits for inspection is another important component of the Campaign and a task in which CESAVESIN personnel are engaged. As per the NOMs, throughout the season of harvest or fructification of host plants, fruits are sampled in orchards, non-farming areas where they grow, and other places where fruits are handled commercially such as packinghouses, processing facilities, distribution markets, and wholesale markets. At mango packinghouses, in particular, personnel of third-party organizations authorized by the government are engaged in sampling and inspecting fruits (see the next chapter for explanation of the organizations engaged in the inspection). Not only commercially grown fruits such as mangos are collected, but also other native host fruit plants grown in non-farming areas.

When I accompanied a team (in their term, *brigada*, Spanish word for brigades) of CESAVESIN personnel in field operation, I witnessed them collect samples from fruits being loaded to a truck on the roadside. A couple CESAVESIN technicians at the office received the samples and chopped them for inspection. At packinghouses and traffic inspection points on highways (to be explained in Chapter 8), responsible personnel would do the same—slice and inspect sampled fruits. As mentioned earlier, the sample fruits must be cut into slices of about one centimeter thick to thoroughly inspect for a larva inside. The CESAVESIN technician at the office swiftly chopped dozens of the sampled mangos brought by the field staff. They repeated this until all the sampled fruits were sliced. One of them told me that on a day in a peak mango-harvest season they would chop as much as 250 kilograms or 500 pounds of mangos. Their cutting-boards (more accurately, round slices of lumber) reflected their repeated cutting in their hollowed center (Figure 7-4). As the technical appendix of NOM-023 dictates, the technician dissecting fruits for inspection should work with precision and agility to be acquired through sufficient training. Understandably, such training cost the technician many wounds until he became capable of wielding the knife so swiftly. He, after throwing the final batch of the samples into a plastic container under the table, said casually, "*Salió nada* (Nothing came out)." His utterance involved nothing exciting and it must have been a mundane scene of the Campaign.

Nonetheless, although this casual utterance, "*Salió nada*," as such will not immediately result in legitimate recognition of an area as pest-free, the nonchalant and even apparently trivial fact that "nothing came out" from a batch of sampled fruits would eventually lead to the significant distinction of pest-freedom of the entire region. As with the case of the monitoring by the McPhail trap, a distinction of whether a fly is in a fruit is elicited by repeated practices of slicing, and as it is accumulated through repeated practices, then, the repeated distinctions will eventually lead to a plausible assumption that there is no pest. *In the strictest sense*, even if no larva is found in every slice of fruits sampled in a geographic area, whether a fly exists in the area cannot be known. Yet, recurring practices of sampling and slicing fruits accumulate the small distinctions of whether the pests exist. Accumulated distinctions, or data, will eventually result in a plausible assumption that there is no pest in the area.

Figure 7-4 CESAVESIN technician inspecting sampled mangos in El Rosario, Sinaloa, Mexico
The hollow surface of the cutting board was a sign of repeated chopping of fruits. (Photo by author)

In southern Sinaloa, which is ALPP, oftentimes adult fruit flies, including the problematic flies and those not subject to the regulation, are caught in the traps, or larvae are discovered in sampled fruits, but optically determining the species of a larva is difficult.[23] In this region where mass-release of sterile fruit flies (Mexican fruit flies *A. ludens*, and West Indian flies *A. obliqua*) is under operation, they are also captured in the traps. Thus, it becomes necessary to identify whether a captured insect is really a problematic pest or not.

In an event of capture of flies, the specimen is brought to the laboratory of CESAVESIN in the southern region for identification. Immature fruit flies found in

[23] I suppose that a microscopic observation of a larva's morphology or even DNA testing would allow identification of species. However, it would be impractical for the Campaign.

sampled fruits are sent to the laboratory and put in Styrofoam boxes (as shown in Figure 7-4) in a secure place to let the larvae grow into adult flies. It is much easier and more practical to use adult flies for determination of species. Adult flies captured by traps are examined to identify species. Additionally, trappers determine whether they are wild insects or artificially reared sterile flies—a sterile fly is marked (as noted earlier in review of the research) with fluorescent in the heads at the *Moscafrut* plant in Chiapas where pupas are mixed with the coloring powder; when flies emerge from the cocoons, the coloring attaches to their forehead.

In the identification laboratory, a CESAVESIN technician optically examines the specimen to determine their species, sex, and if they are *A. ludens* or *A. obliqua*, then whether released or wild insects. During my participant observation, the quiet technician poured the insects in a bottle onto a petri on a microscope, piled them up on one side, picked one by one from the pile with tweezers, inspected each, and then moved it to either a pile of female flies or another for male on the other side (Figure 7-5). To determine whether a fly is wild or reared, he squeezed the fly's neck with the tweezers to pull out its fluorescent-marked forehead retracted between its compound eyes. If the head is shining with the fluorescent, the fly is not a wild one. In some cases, when the mark was not clear, he used the microscope to shed strong light from beneath the insect to elicit pinkish shining reflection of the coloring. He let me try this, but to my eyes—I have light color blindness—the fluorescent looked orangish rather than pink. In rarer cases when he was still unsure (there were no such cases during my observation, but he demonstrated to show me), he would remove the fly's head, press and spread it on a filter paper, and shed light to surely see the distinctive fluorescent. During my observation, no target pests (wild flies of the *Anastrepha* species) were found. Yet, he would definitely find some of them sooner or later as the mango-harvest season advanced. Having finished examining specimens in a bottle, he took records of each inspection, including numbers of insects, species, sex, whether wild or sterilized, on a form. After completing the form, he would give it to a secretary who input the data into a database.

Figure 7-5 Identification of fruit flies in the CESAVESIN laboratory in El Rosario, Sinaloa, Mexico
(Photo by author)

In a peak season, as with the technician inspecting sampled fruits, he would have to inspect thousands of flies a day. Compared to the inspection by the skillful dissection of fruits, the identification task in the laboratory entailed more complex procedures and required substantial knowledge in morphologies of the pests and techniques in handling them. However, again, the identification was constituted with repeated practices that make the apparently minuscule distinction between pest and non-pest of each tiny insect (although sterile flies are pest species, they are not treated as problematic pests). And, it is this practice, as repeated, accumulated and recorded, that eventually leads to establishment of the boundary of pest-free at the significantly large geographic scale.

7.2.3 Biological control: Elegant stinger of parasitoid wasp

The Campaign employs a variety of measures to reduce and/or eliminate wild flies in the field. Biological control using natural enemies of the fruit fly pests is such an example. Biological control refers to pest management practices using natural enemies such as predators, competitors, parasites, or parasitoids in order to suppress a pest population in the field. Whereas a parasite means an organism that lives for most of its life in or on another organism (host) and is usually not lethal to its host (although it may cause some damage), a parasitoid refers to an organism that in its immature stage parasites in another organism and eventually kills the host (Dent and Elliott 1995; Norris, Caswell-Chen, and Kogan 2003). A well-known example is the introduction of an exotic (non-native) predator, Vedalia beetle (*Rodalia cardinalis*) for control of the cotton scale *Icerya purchasi,* which damaged citrus in the United States during the 1880s (Dent 1995). As an important component of IPM, biological control measures have advantages, including reduction of pesticide use, little impact on the ecosystem, and cost effectiveness (Aluja [1993] 1994; Norris, Caswell-Chen, and Kogan 2003). Certainly, there are known drawbacks, including its modest effect, inflexibility in application in fields, and intensive knowledge required to identify and rear an effective natural enemy. Also, the cost effectiveness of biological control is premised upon the assumption that once an enemy population is established in an area subject to control, its effect lasts permanently or at least for a considerable time period. However, the permanent establishment of a biological control agent, which was previously considered as a benefit, now can be viewed as an impediment because the establishment cannot be "undone" and may engender unpredicted and undesired outcomes in ecosystems (Syrett 2002).

In the control of *Tephritidae* pests, interest in using parasitic *Hymenoptera* (wasps, bees, and ants) species as biological control agents can be dated back to the early twentieth century; since then, over 100 parasitoid species have been tested (Wharton and Yoder N.d.). As *Hymenoptera* parasitoids lay eggs in immature fruit flies (i.e., eggs and larva) eventually killing them, artificially reared and released parasitoids can be used to suppress wild fruit fly populations. In Mexico, as reviewed above, since the 1950s parasitoid wasps, both native and introduced foreign species, have been tested or liberated (Aluja [1993] 1994; López, Aluja, and Sivinski 1999), and the active search for biological control agents, including methods of mass-rearing, has continued. Among them, *Diachasmimorpha longicaudata*, a parasitoid wasp, native of the Indo-Pacific region, is one of the most important biological agents in the control of fruit flies applied in the United States (Hawaii and Florida), Latin America, and elsewhere (Wharton and Yoder N.d.). Female adults of *D. longicaudata* are 3.6 to 5.4 mm long not including ovipositor, while male adults are 2.8 to 4.0 mm long; the female lays eggs using her elongated ovipositor—looking like a straight, even elegant, sword—which is often longer than the body and allows her to reach fly larvae inside a fruit (Figure 7-7). *D. longicaudata* has been successfully mass-reared and released for pest control since the 1950s in Mexico (Aluja [1993] 1994; Wharton and Yoder N.d.), including Sinaloa, primarily in non-farming, wilderness areas where higher fruit fly infestation is found.

This parasitoid wasp is artificially reared in the plant for mass-rearing of sterile flies in Chiapas because it feeds, namely, on fruit flies. Reared pupae are transported by airplanes to a nearby airport then transferred to a facility of CESAVESIN where they emerge to become adult wasps in paper bags. The full-grown wasps, having emerged from pupae, are transported to sites of release either aerially or by truck, then manually liberated. The use of the wasp (and other potential organisms under investigation) for biological control epitomizes the diversity of agents, whether human or non-human, constituting the network of regulation.

Interestingly and arguably, no one would track all the wasps released in the field and witness exactly what would happen to them. Some of them might successfully find an immature fly in fruits and lay eggs into its body using their elegant sword-like ovipositor, eventually terminating its life. Or, others might end up wandering in the field and eventually dying, without being able to find any larva. Still, as far as wasps are released constantly and traps capture less and less flies in the area where they were released, we can "know," even if we do not witness it on site, that this agent has done its job.

Figure 7-6 *Diachasmimorpha longicaudata*, a parasitoid wasp in El Rosario, Sinaloa, Mexico
The wasp with a remarkably long straight ovipositor is used for biological control against fruit flies (Photo by author)

7.2.4 Sterile Insect Technique: Set a thief to catch a thief?

Another "weapon" of the Campaign to eradicate fruit flies, specifically, Mexican fruit fly (*A. ludens*) and West Indian fruit fly (*A. obliqua*), is the use of sterile insect technique (SIT). SIT is likened to a "birth control" technique aiming to suppress, or eradicate, a wild pest insect population by rearing and releasing a massive number of sterile male insects to fields where they mate with females, which will lay only infertile eggs. Continuous release will deprive the wild insect population of the chance of reproduction, thereby eventually suppressing the wild pest population. SIT is applied near completion of an eradication program because it is ineffective when a population density of wild insects is still high (ratio of released sterile insects to wild insects must be so overwhelmingly high that a wild female insect cannot find a wild fertile male). Generally, combined with support by other techniques such as chemical control, SIT constitutes one of the key components of AW-IPM to eradicate or prevent (re)establishment of a pest population in a certain geographic area (Klassen 2005).

The idea of using sterile insects for pest control can be dated back to the early twentieth century. But, not until the 1950s was the first notable success recorded with an eradication program against New World screwworm, an animal parasite (a fly) that was causing devastating damage to livestock in the United States and Central America (Calkins, Klassen, and Liedo 1992; Ebbels 2003; Klassen and Curtis 2005). Since then, successful applications of SIT have been reported in various pest control programs, including those against gypsy moth and cotton boll weevil in the United States as well as fruit flies in the United States, Japan, and Mexico (Klassen 2005). Where it is feasible, SIT can be cost-effective without causing significant damage to the environment, although there are many conditions for a successful SIT program to meet (Ebbels 2003). For instance, an SIT program against *Tephritidae* needs a large-scale facility to rear tens or hundreds of millions of flies weekly, equipped with an irradiation apparatus to make reared flies infertile, transportation of flies to fields, and devices for release, along with sizable financial resources including initial startup capital as well as running costs of the program (Hendrichs 2000). To launch the SIT program for the eradication program against Mediterranean fruit flies, as mentioned above, Mexico with the support of the United States constructed a mass-rearing plant (*Moscamed* plant) in Metapa de Domínguez, Chiapas, in 1979 and expanded the plant to produce sterile *Anastrepha* flies in 1992 with the capacity of producing 300 million pupae weekly (*Moscafrut* plant).

The *Moscafrut* plant, which I visited in March 2009, was an enormous and complex facility composed of fine-tuned subcomponents (Figure 7-8). It began with establishing “colonies” of artificially grown flies. While maintaining them for generations, the technicians have kept improving techniques for more efficient production, for instance, the best-balanced diet (feeds) (Figure 7-8-5), the optimum temperature and humidity for growing flies and larvae (Figure 7-8-1 and 6), a “trick” to induce female flies to oviposit (Figure 7-8-2), and efficient means to separate larvae from feeding medium and pupae from pupation medium (Figure 7-8-8 and 11), among others (Domínguez Gordillo and Castellanos Hernández 2005). Besides a couple of remaining technical challenges under investigation, including establishment of techniques for mass-rearing of guava fruit fly (*A. striata*), and as mentioned earlier, selective mass-rearing technique of male flies, critically important and perpetual problems of the mass-rearing were cost-reduction and quality control of reared flies. Despite these challenges being addressed in the *Moscafrut* plant, the photos demonstrate a complex system that has been built, mobilizing and assembling human and non-human beings, biological and non-biological agents, into a series of procedures, or a materially heterogeneous network of (sub)components of the PS regulation system.

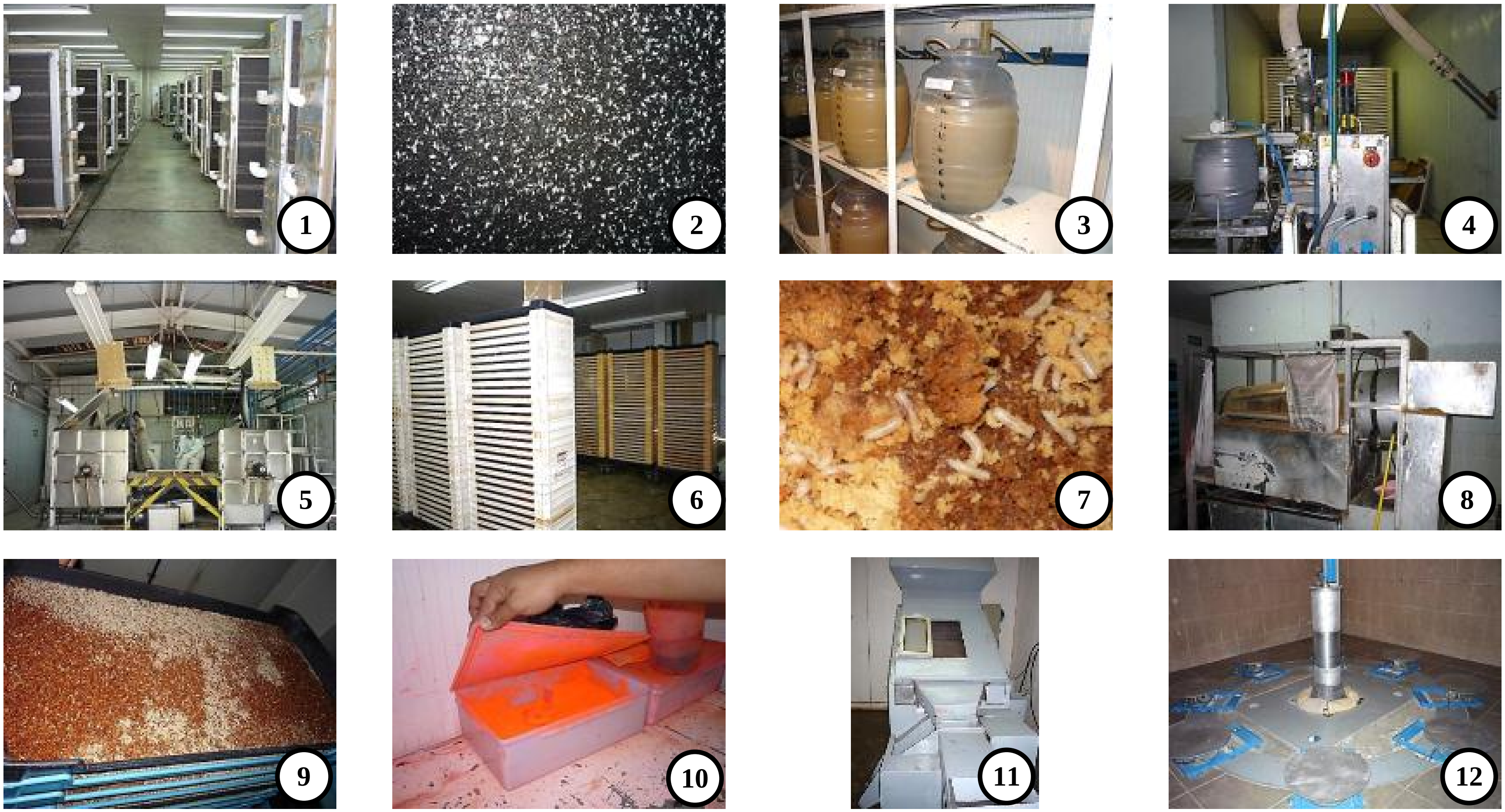

Figure 7-7 Procedure of mass-rearing of sterile fruit flies in Metapa, Chiapas, Mexico (See the next page for explanations of each process) (Photos by author)

Figure 7-7

Photo 1: Colonies of adult flies maintained in screen cages. Temperature and humidity of the room was optimized for the insect.

Photo 2: Eggs of fruit flies (small white lumps against the black backdrop). Female flies mistakenly laid on silicone gum attached on screen. The use of the gummy silicone was one of many serendipitous but ingenious devices developed in *Planta Moscafrut*. Eggs were rinsed off by gentle water spray.

Photo 3: Incubation of eggs (3 or 4 days, depending on species) in water circulated by injected air for supply of oxygen.

Photo 4: Planting eggs. Eggs were pumped out from the incubation bottle and automatically sprayed on a tray filled with feeding medium.

Photo 5: Massive feed blender. Basic ingredients of feeding medium for larvae include water, corncob powder, corn flour, sugar, torula yeast, and so forth.

Photo 6: Stacks of trays containing larvae in the incubation room. Larvae go through three stages (instars), each of which lasts five to eight days depending on species. Temperature is manipulated to synchronize timing of hatching and regulate the development stages of larvae, varying 25 to 38 degrees Celsius.

Photo 7: Larvae (second or third instar) and feeding medium.

Photo 8: Riddling machine to separate larvae and feed medium. The mesh drum at the center, turning round, separates larvae and feeding medium.

Photo 9: Pupae (brown, darker color) and larvae (white, lighter color). The larvae would pupate shortly.

Photo 10: Dye to mark pupae for identification.

Photo 11: Blower to separate pupae from waste.

Photo 12: Irradiation chamber. Gamma-ray source (Cobalt 60) was stored underneath the floor. When starting an irradiation treatment, it would rise from the floor. Of course, when in use, no human shall be inside.

In the meantime, the quality control of flies, which in this context referred to the competency of reared insects to fly robustly in the field and find and mate with wild flies, was addressed by incessant monitoring, the key concept underlying the whole PS regulatory network. Quality control measures were applied not only to humans, as witnessed in the case of the nested monitoring of trappers, but also to non-humans. Sterile fruit flies reared in the *Planta Moscafrut* were under strict quality control.

Due to exposure to irradiation, sterilized fruit flies tend to be weaker compared with wild insects in their reproductive capacities, including the ability to fly to find a wild fly with which to successfully copulate. To assure the quality of a specific batch of fruit flies, the quality control department of *Planta Moscafrut* kept sampling pupas from a batch and conducting quality testing, including counts of eclosion and testing capacity to fly (Figure 7-8). Results of the quality testing will constitute feedback to the rearing procedure to improve it, including optimizing balance of feeds. Ensuring the quality of mass-reared, sterile fruit flies was one of the urgent concerns facing researchers and technicians engaged in the eradication program, because there was strong pressure to reduce costs and to respond to growing demands for sterile flies. While it was ironic that mass-reared fruit flies in *Planta Moscafruta* were under thorough and generous care as if they were not a vicious pest, it was also essential for the success of the Campaign to eliminate uncertainties in any aspect of the operations.

Figure 7-8 Format for quality control of mass-reared fruit flies at Planta Moscafruit in Metapa, Chiapas, Mexico
Frequencies of adult flies emerging from pupas are counted for quality evaluation of the mass-rear processes (Photo by author)

As with the parasitoid wasp, *D. longicaudata*, sterile fruit flies in the form of pupas reared in the plant in Chiapas are air-shipped to several states of Mexico where SIT for eradication is in operation as stipulated by NOM-023. In Sinaloa, personnel of the CESAVESIN office in the city of El Rosario regularly receive shipments of pupae at the local airport. Upon arrival to an eclosion facility attached to the CESAVESIN office, pupas are repacked in paper bags and put in an emergence room where temperature and relative humidity are optimized for the flies to hatch. Adult fruit flies after emergence are packed in a device specifically designed for air-release. This device, filled with adult sterile flies, is loaded on a plane. While flying, this plane releases the flies inside constantly in an automatic manner. From the CESAVESIN office (to which an airstrip is attached), a couple of aircrafts fly almost daily to release sterile flies in the field. Flights take place in early morning before air conditions become turbulent.

During my fieldwork, I had an opportunity to accompany such a flight for release. I flew with one of the two old Cessna aircrafts, which, according to the young pilot, had just recently got a new engine. Right behind the front seats, a few CESAVESIN technicians loaded the release box with a holding capacity of five million sterile flies (Figure 7-10-1). Then, I climbed up to the co-pilot seat for which no belt to buckle up was equipped. As the Cessna started to taxi onto the airstrip, through the aircraft's windshield, I saw a few familiar faces of CESAVESIN technicians shouting to me, "Do you have a bag?" (for throwing up), rousing laughter. But, the flight was smooth except when the pilot suddenly banked the aircraft trying to frighten me. After takeoff, over the roar of the new engine he and I had a fairly animated (or it might sound so because we had to talk loud) conversation about his work, his ten years of flight experience since he was sixteen years old, and his father and siblings, who were also pilots engaged in aerial spraying. Shouting in the roar tired us, and after quick topics of conversation ran out, we remained silent. The pilot then started to listen to music as he normally would do when flying alone. I took pictures of mango groves underneath. As we approached our destination, an area of over 3000 hectares surrounding Escuinapa, he adjusted the course toward the release area with the guidance of a GPS device (Figure 7-10-2). As our plane entered the target area, as shown on the screen of the GPS, the pilot pulled a knob on the front panel to start releasing the sterile flies. Evidence of release began appearing on the GPS (Figure 7-10-3). Although the silver release box behind me supposedly began slowly releasing sterile flies transported from one thousand miles away, I could not see from the tight co-pilot seat how they were being released into the air. The pilot was just listening to music. Only when we reached the end of the release area (which we could know only through the GPS device), he firmly grabbed the control stick, banking the Cessna to repeat the process (he said he would usually make a much sharper turn). The only evidence of making progress is a black band extending on the GPS screen, indicating the flight path through which the flies were released (Figure 7-10-4). As our Cessna flew back and forth over the release area, stripes of black bands on the screen eventually covered all of the target area (Figure 7-10-5). After finishing the release, the flight to return to El Rosario was quick and the landing was much gentler than most commercial flights. After our landing, on the way back to the apron (or CESAVESIN's parking space), he said that his friends envied his job of flying every day; but, although it had been exciting at first—he loved flying anyway—in fact just after a while, it became boring, mundane, repetitive work.

Figure 7-9 Procedure of aerial release of sterile fruit flies during a flight over El Rosario and Escuinapa, Sinaloa, Mexico

(Photo by author)

1. Release box loaded on the plane.
2. The aircraft approaching the release area indicated on GPS device.
3. The aircraft began to release fruit flies. The black "band" indicates the aircraft's path releasing sterile flies.
4. Aircraft went back and forth on the area continuing the release.
5. Release completed.

Indeed, as with the case of trapping and sampling for inspection by slicing fruits and identification, it could be argued that it is such mundane, repetitive, even boring, practices that keep drawing boundaries between pest/non-pest. Interestingly, and arguably, again, no one would pursue and witness exactly what would happen to all the sterile flies released from a couple of hundred meters above the ground. Some of them might successfully copulate with wild flies, terminating their reproduction cycle. Or, others might end up feeding birds (and at least about half of the released insects, namely, female flies, do not serve to suppress the wild fly). What converts such invisibility and uncertainty into something visible and relatively certain is the GPS monitor (Figure 7-10 above) as another inscription device. The course of a flight releasing sterile insects was made visible by the GPS device so as to generate secure “data.” Under the theory that sterile flies released at an inundating scale will deprive wild insects of the chances of “natural” copulation, the accumulated data proving the mass-release serves to secure a plausible assumption that the density of wild flies decreases, regardless of what really happened to the released insects in the field.

On the ground where the released flies are expected to suppress wild flies, the web of McPhail traps, as explained earlier, is awaiting insects to be entrapped. CESAVESIN’s trappers also repeat their field trips to inspect traps. The traps capture both released sterile and wild flies. As trap inspections are repeated, hopefully, only sterile files come to be detected and no wild flies are captured in a certain area. That is when the area is deemed free of the pest.

7.2.5 Mechanical-cultural control: Globalization in your backyard?

The mechanical-cultural control against fruit flies is a very effective, simple, and efficient measure, and according to the technical appendix of NOM-023, when carried out under a well-designed scheme, it could reduce the wild fly population up to 60 percent. Generally, the mechanical-cultural control includes a wide variety of practices to reduce the chance of infestation of plants with pests and they are simple and feasible for even less-resourceful farmers. Basic cultivation practices, including growing vigorous plants through proper fertilization and soil management, control of weeds to eliminate where pests can hide, and elimination of infested crops, are examples of preventive actions.[24] In the control of *Tephritidae* pests, this approach is essential to sever the lifecycle of the insect by, for instance, collecting and disposing of infested fruits (e.g., burning, treating with lime, or burying deep in soil), eliminating non-commercial host plants, and controlling weeds. To better control the pest through cultivation practices, moreover, a grove involving different crops or varieties varying in their harvest seasons requires specific caution because they provide the pest with fruit throughout the year, making such a grove "a true heaven for the pest" (Aluja [1993] 1994:128).

In the Campaign, the mechanical-cultural control consists of elimination or destruction of non-commercial host fruit plants, and good management of commercial groves including weed control as well as appropriate disposal of unharvested or non-marketed fruits of commercial crops such as mangos. Most of these preventive measures are to be carried out by growers in their own orchards. Most commercial growers wishing

[24] Also, post-harvest treatment of fruits, including heat treatment with hot water or air, are often deemed mechanical-cultural control measures.

to market mangos in the country (and all growers wishing to export mangos to the United States) have to practice these measures in order to qualify for the registration and certification of their groves for shipment of fruits, as per the NOMs governing the Campaign. One of many challenges of the *Tephritidae* pest control, however, is to manage host fruits grown naturally or not for commercial purposes in non-farming areas, such as urban-residential areas and wild forests, where the pest can take refuge. In Sinaloa, therefore, the pest control in these areas is undertaken by CESAVESIN.

As this case indicates, the Campaign reaches not only growers but also non-farming areas and ordinary people's lives. I observed such activities when I joined a group of CESAVESIN personnel in an operation in central Sinaloa. This field operation was somewhat unusual as it was part of the intense emergency action against sporadic occurrences of the pest in the area, which was already recognized as pest-free. The team, or "*brigada*" (brigade) of CESAVESIN technicians were involved in various activities such as intense trapping, spraying in urban areas (to be explained in the next section), and mechanical-cultural control. In the search for infested plants in Navolato, a town near Culiacán, the state capital, they spotted, in a backyard, a tree of *ciruelo* or *jocote*, commonly known as "Spanish plum,"[25] a host fruit plant preferred by fruit flies. The CESAVESIN crew examined fruits and found maggots in them, then requested that the owner eliminate the plant (Figure 7-11). The tree was too big and the family loved it as it

[25] Spanish plums belong to *Spondias*, a genus of *Anacardiaceae* family, and are different from the fruit known commonly as plum in the United States (*Prunus*, *Rosaceae* family). Mango (genus *Mangifera*) also belongs to *Anacardiaceae* family.

provided shade in the garden; although the family would not eliminate it, they agreed to collect fruits and bury them deep in soil to prevent larvae from emerging from fruits.

In another case, I witnessed the crew members cut down a host plant tree upon the owner's consent (Figure 7-12). They eliminated the tree, collected all fruits and branches on the ground, poured chemicals onto the stump to completely kill the tree, and cleaned up the backyard. In such a case where people cooperated with the Campaign, CESAVESIN provided the owner with seedlings of oranges or grapefruits for the price of the eliminated plant. While orange and grapefruit are in fact fruits highly preferred by fruit flies, the assumption was that people would give more care to the trees to harvest fruits than the native host fruits such as *ciruelo,* which are, though edible as well, more likely to remain unharvested or just left on the ground creating safe refuge for the pests.

The *brigada*'s activity in backyards illuminated how the Campaign was creating certain orders among things, and perhaps humans, in accordance with the regulations. As with disqualified mangos sorted out before post-harvest treatment (in the previous chapter), some fruit trees were not only disqualified for export or even commercial shipment. In the Campaign, the host trees, as well as gardens where they grow or their owners, were put under control measures. If, in a PFA, the pest reappeared, urging an emergency action, these host trees would be hunted and spotted, even worse—or better from the regulator perspective—eliminated, or at the least, their fruits were ordered to be buried. Of course, possessing the host fruit plants in a backyard *per se* was neither illegal nor immoral—yet. As c*iruelos* or *jocotes*, and other native edible fruit plants abound in the area and have been consumed by local people, it was not reasonable to eliminate them completely. Nonetheless, it was still the case that they were already subject to ordering effects by global PS regulations.

Figure 7-10 CESAVESIN technicians requesting the owner of a host plant to collect frutis to prevent fruit flies in Navorato, Sinaloa, Mexico (Photo by author)

Figure 7-11 CESAVESIN personnel cutting down a host plant (ciruelo) in Navorato, Sinaloa, Mexico
(Photo by author)

7.2.6 Chemical control: Urban areas as battlefield?

Another important component of the Campaign to suppress wild fruit flies is chemical control. Basically, this means application (spraying) of pesticide, although chemical control in a broader sense can include post-harvest treatment using fumigants such as MB or EDB. Because fruit flies are susceptible to a variety of insecticides, there are many options of applicable insecticides. Cost and potential impacts on the environment are the most important factors in selecting a pesticide to apply. Several textual sources in fruit fly control and mango production (e.g., Aluja [1993] 1994; Ireta and Guzmán 2002; White and Elson-Harris 1992) refer to Malathion, an organophosphate insecticide, as one of the most commonly used substances for the control of fruit fly pest.

Malathion has been registered as a pesticide in the United States since 1956 and the most commonly used organophosphate pesticide in the country. It is applied in agriculture, residential gardens, public recreation areas, and in public health pest control programs, including mosquito control for prevention of malaria and West Nile disease. When applied appropriately, it can effectively control pests without posing unreasonable risks to human health and/or the environment (U.S. Environmental Protection Agency 2008).

Whereas pesticides, including Malathion, can be fumigated to all trees in an entire orchard or to a wider area by sprayers or airplanes, spot application of the pesticide, combined with "bait," or attractant to the pest also used for the McPhail trap, is more often recommended. Bait-insecticide solution, containing hydrolyzed protein and insecticide, was developed for fruit flies in the 1950s in Hawaii (Christensen 1958). This mixture is often applied as "spot spray," which means to repeatedly spray very limited amounts of the solution onto a plant (ideally a host plant), although aerial blanket fumigation of a bait-insecticide mixture of very low concentration can also be practiced. Female fruit flies needing protein sources to develop eggs are attracted to hydrolyzed protein contained in the sprayed spot, then touch the pesticide, which is absorbed through their skin and kills them. In general, the use of a bait-insecticide mixture applied as spot-spray allows cost-effective application and reduction of possible risks to human health and the environment. Also, traps made with plastic bottles of soft drink containing bait/insecticide mixture are installed to detect, attract, entrap, and kill the pest. The field technicians call these traps "*trampas matadores*" (killer traps) in Sinaloa.[26]

In the Campaign in Sinaloa, for commercial orchard areas bait-insecticide mixture was sprayed aerially, that is, by airplanes (each owner could apply pesticide to her or his orchard, if necessary, as part of usual pest control). In the non-commercial areas, including urban residential areas and wilderness areas, aerial spraying was no longer allowed, according to a CESAVESIN senior officer. In non-commercial farming areas, therefore, the spraying was carried out by CESAVESIN technicians on the ground. CESAVESIN technicians would make a *brigada*, riding on a pickup truck equipped with a 400-liter mixture tank, a pressure pump, and two high-pressure nozzles (Figure 7-13). As per a regional spraying plan elaborated based on pest detection records, the *brigada* would make expeditions to remote forests or residential zones in urban areas.

[26] While the field technicians certainly called this type of trap *matador*, a CESAVESIN senior officer denied such a name and instead called "*estación cebo* (bait station)," which aimed to attract flies primarily for detection rather than suppression of the pest as such.

Figure 7-12 Equipment of chemical control (insecticide spraying) in preparation for expedition in Sinaloa, Mexico
(Photo by author)

Figure 7-13 "Spot" spray of bait-insecticide mix in a town near Culiacán, Sinaloa, Mexico
(Photo by author)

In an expedition I accompanied, two technicians and I made the round of several towns near Culiacán to spray host plant trees. A CESAVESIN technician, wearing a mask and a hood for protection and sitting on the cargo bed of the pickup running slowly, kept giving flashes of spray to trees on roadsides and yards facing streets (Figure 7-14). The flash sprays, which left spots or stains of bait-insecticide mixture on target trees, would suffice to attract and kill flies supposedly proliferating in the area. Outside temperatures rising to perhaps 32 or even 35 degrees Celsius (90 to 95 Fahrenheit) and the high humidity of the semi-tropical zone in October must have made the technician feel unbearably hot under the protection equipment. Nonetheless, the spraying expedition was slow not to miss host plants in the towns we visited. I saw beads of sweat on his forehead every time he took the mask off until we finished the expedition to spray six towns.

In the case of chemical controls such as this one, because it obviously entailed fumigation of insecticide, there could be concerns about potential hazards for human health and the environment. During the expedition for fumigation, I witnessed a few residents with infants escape into their houses in a hurry as they noticed the spraying. Although CESAVESIN informed the governments of the municipalities where the Campaign operated (and an officer alluded that CESAVESIN had announced its presence through radio as well), many people obviously did not know about the Campaign (otherwise, why did the CESAVESIN personnel have to explain what they were doing to people in the town?)

To delve further into this issue, I interviewed a representative of the state health department. His response was that since pesticides in general posed health and environmental risks, strong legal controls including pesticide registration were applied whether a pesticide was used in private farms by owners or in public places by CESAVESIN; as far as a registered chemical was used in an appropriate manner, there should not be unreasonable health concerns. Yet, he acknowledged that people were concerned about pesticides in general and there was a non-governmental, non-profit, organization actively committed to addressing such concerns. According to him, however, intense reactions against the pesticide use as such were rarely heard. Likewise, to my question asking if they heard complaints about spraying, a couple of CESAVESIN technicians answered that certainly there had been complains, but they were concerned about stains on clothes hanging in the backyard (the bait-insecticide mixture leaves dark hard-to-wash-off spots) or noise of fumigation. A possible reason for the docile—or no—reaction to the spraying in urban areas might be that in semi-tropical Sinaloa where diseases transmitted by insects (e.g., dengue fever) prevailed, spraying in urban residential areas for pest control, especially to kill mosquitos, was a quite common practice (I witnessed this once in my neighborhood). Besides, the flash spot spraying could limit diffusion of pesticide to the atmosphere (aerial spraying in non-farming areas was already prohibited, as mentioned); and CESAVESIN technicians were trained to not spray when people were in sight. Indeed, CESAVESIN technicians had to demonstrate exemplary practices in pesticide application, given pesticide intoxication cases reported in the state.[27]

[27] During the fieldwork, I heard from my colleague at IIES quite a few stories about intoxication among workers in large-scale commercial vegetable farms.

Besides the use of pesticides, especially in urban areas, which could be a serious safety concern for residents, what drew my attention was that the operation of the Campaign was no longer carried out solely in orchards of mangos or other commercial fruit products. Expeditions for spraying in non-commercial farming zones were always undertaken somewhere in the state. To clean up the areas and enable exports of these fruit products without treatment, the Campaign was already involving, whether posing health hazards or leaving stains on hanging clothes, those who were not directly involved in the production of mangos or other fruits. For the same purpose, as demonstrated with the cases of the post-harvest treatment and the mechanical-cultural control, some plants or fruits that did not qualify for trade—although they were edible and some people consumed them—were excluded. Also, the regulatory network for the Campaign involved other organizations and institutions (e.g., local governments or the health department). In essence, the web of the PS regulatory network was extending its reach out of the farming sector, crossing spatial and institutional/organizational boundaries, creating orders among things, places, or humans so as to make them conform to the global regulation for agro-commodity trade, even in backyards of Mexican towns.

I am not condemning this trend but wishing to shed light on the making of some agricultural products I am familiar with. Also, I want to note that during my observation, the CESAVESIN personnel in the field were very polite and thorough in explaining the Campaign to individuals who asked questions or those whom they asked for cooperation. Still, it was the case that the making of the order permeating through the Campaign into non-farming areas and non-farming people could engender normative expectations among them to conform to the regulation. Before I will delve into the observation of emerging norms in Chapter 9, however, in following sections I will further present how the Campaign was extending its reach through other PS control measures, such as traffic inspections on highways, to ordinary (i.e., non-farming) people.

7.2.7 PFA and legal control: Expanding network of regulation

The PS activities in Sinaloa described above, from the detection and identification of pests to SIT and bait-spraying, were principally intended to establish PFAs and protect them in the state from re-invasion of fruit flies. According to International Standards for Phytosanitary Measures (ISPM) by IPPC, a Pest Free Area (PFA) is defined as "an area in which a specific pest does not occur as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained" (Convention 2007). Central to this concept is to integrate three program components to establish and maintain a PFA, including (1) systems to establish freedom, (2) PS measures to maintain freedom, and (3) checks to verify freedom has been maintained (IPPC 1995). Actions needed for a PFA include a survey of documented data (on a target pest and its hosts), trapping, maintaining fruit identity (i.e. origin of a fruit must be always certified), activities for prevention and emergency action, such as bait-insecticide spray and biological control, SIT, survey, and control of alternative host plants, regulation over movement of fruits and alternative host plants, and close monitoring of these activities to maintain the integrity of the entire program (Riherd, Nguyen, and Brazzel 1994).

Once a pest species could be eliminated using the variety of measures from a certain geographic area, it should be recognized officially as pest-free by national PS authorities of both exporting and importing countries of commodities produced in the area. Standards or procedures to establish and recognize a PFA are governed by the above ISPM, along with Regional Standards for Phytosanitary Measures elaborated by the NAPPO (RSPM, for example, North American Plant Protection Organizatioin (2010)) that prescribe detailed rulings applicable to the three north American countries: Canada, Mexico, and the United States. Of course, to conform to these international standards, the national governments establish other more specific rules within their territories. As overviewed so far, the PS regulations, whether the Campaign or post-harvest treatments, employ a variety of non-textual artifacts as well as non-human agents to physically enact the rules. Arguably, however, their legitimacy is buttressed with legal documents in the form of textual artifacts. Without this specific function of the textual material—texts are specific signs inscribed in material such as papers or electronic files—easily transcending administrative hierarchies and geographic boundaries (i.e., international, regional, and national), PS regulations as material politics would not be possible. Combining the heterogeneous materiality, PS regulations constitute the regulatory network that creates orderings among those who (or that) are involved.

The first PFA program started in the Rio Grande Valley, southern Texas, against Mexican fruit fly (*A ludens*) in 1981, then in the following year the second case was launched in Florida against Caribbean fruit fly (*A. suspensa*). The PFA concept, because of its history associated with fruit fly pests, was intended primarily to certify the area free from economically important fruit flies. Similar programs for other pests in different countries are also in progress (Riherd, Nguyen, and Brazzel 1994). In Mexico, the first PFA was established in Sonora in 1987, a northwestern state, from which fruits susceptible to harm by the *Anastrepha* pests can be exported to the United States with no post-harvest treatment. Efforts to establish PFAs have continued in other areas of the country. As of January 2011, 50.25 percent (984,479 square kilometers (km^2)) of the national territory was recognized as pest free by the Mexican government; 10.44 percent (204,497 km^2) was recognized as ALPP; and 39.91 percent (770,272 km^2) was categorized as areas under PS control according to the SAGARPA-DGSV (2011). In Sinaloa, furthermore, the southern six municipalities were expected to be recognized as pest-free in 2012, according to interviews with officials of SAGARPA and CESAVESIN. In the meantime, as of October 2011, USDA-APHIS has officially recognized five municipalities of Baja California Sur; six municipalities of Chihuahua; five municipalities of Sinaloa as already explained, and 21 municipalities of Sonora, as pest free (USDA-APHIS 2010).

A PFA and an ALPP, once established and recognized, requires continuous acts to protect from invasion of concerned pests from outside. Especially, given that *Tephritidae* pests are highly mobile and adaptive to diverse environments including non-farming sites, it is crucial for PS regulators to apply regulatory actions beyond venues of production (e.g., orchards) and processing and distribution (e.g., packinghouse and wholesale market) of a commodity. In addition, immature fruit flies can “hitchhike” on host fruits transported from one place to another. Accordingly, legally endorsed mandatory regulations to regulate transport of host plants, including certification for movement (transportation) of fruits, certification of origin and disinfection treatment, record of pest control measures, and inspection of traffic carrying fruits at airport, seaports, and highways, must be carried out.

The Campaign against Fruit Flies in Mexico employs these typical legal measures. As overviewed earlier (Appendix 3), NOM-075-FITO-1997 regulates transport of 47 host fruits in combination with clauses of NOM-023-1995 that command the inspection and registration of orchards to qualify for shipment of host fruits. At airports, seaports, railway stations, or *Puntos de Verificación e Inspección Interna* (PVIs, Internal Verification and Inspection Points), federal or local personnel of CESAVESIN (which is one of 33 CESAVEs in Mexico) are stationed for inspection of cargo or passengers' luggage. There are 45 PVIs under direct control by the federal government and 67 PVIs managed by CESAVES as auxiliary bodies, or organizations of farmers virtually delegated the authority to inspect transportation of plant products (I detail roles of CESAVES as auxiliary bodies in the next chapter).[28] The federal PVIs are strategically arranged on points where major highways cross five hypothetical "*cordónes* (cordons)," or lines of vigilance, to monitor the transport of plants, animals, and related products, throughout the country (Figure 7-14Figure 7-15). All traffic passing through these PVIs must be inspected, and if carrying host fruits, has to be accompanied with certification. For instance, when an ordinary citizen travels in a vehicle carrying apples or oranges for a snack on the road without a document verifying their origin and/or proofing history of a PS treatment, they can be confiscated and destroyed at a PVI.

[28] There are 255 PVIs to inspect exclusively transportation of animals and animal products.

Figure 7-14 Five Cordons for PS and animal health inspections in Mexico

Elaboration by author based on SAGARPA-DGIF (2010), SAGARPA-DGSV (2008d) and a map image by INEGI

1. *Cordón Norte* (Northern Cordon)
2. *Cordón Centro* (Central Cordon)
3. *Cordón Sur* (Southern Cordon)
4. *Cordón Istmo* (Isthmus Cordon)
5. *Cordón Penunsular* (Peninsular Cordon)

In the state of Sinaloa, there are six PVIs, including two federally-operated and the rest managed by CESAVESIN. The two federal PVIs are located at “entrance” points on two major highways coming from the south (Nayarit) to the southern ALPP; two PVIs operated by CESAVESIN are on two highways on the border between ALPP and the central PFA; one on the border between the northern PFA and the central PFA; and one on the highway from Durango (east of Sinaloa). At these PVIs, SAGARPA officials and personnel of CESAVESIN are engaged for 24 hours, 365 days, in regulatory activities including inspection of all transportation passing there.

This rigid physical setting of the PVI included a bump or “sleeping police,” a device that forcibly slows down the traffic and is an infamous example of ANT’s claim on the significance of non-humans controlling human acts (Figure 7-15) (Latour 1999; Law and Mol 2008). The primary purpose of the bump might be to protect the inspectors working there (some reckless drivers have exposed the CESAVESIN personnel there to danger of serious injury). Still, as with the double screen door in the packinghouses (Chapter 6), it might be a hallmark of PS regulations to incorporate mechanisms or devices that rigidly and forcibly regulate movements of humans and non-humans.

Figure 7-15 “Las Brisas,” installed at the entrance to the northern PFA in Guasave, Sinaloa, Mexico
All traffic, whether freight or passenger, is subject to inspection. At the gate, a bump was installed to forcibly slowdown traffic. (Photo by author)

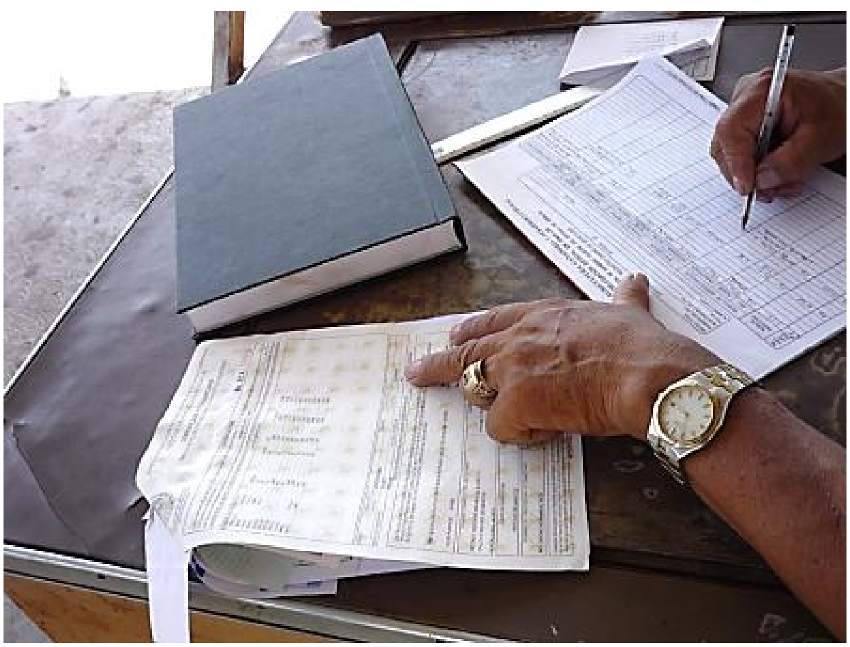

Figure 7-16 Inspection of PS certificate at the PVI "Las Brisas"
Without documentation, host fruits cannot be transported beyond a PVI. (Photo by author)

At the PVI, if regulated host fruits are found transported without PS certification issued as per NOM-023 (Figure 7-16), they have to go through a quarantine treatment such as fumigation (Figure 7-17) or be abandoned. All retained fruits are tested by dissecting to see if fruit fly larvae have infected them. The general inspection at a PVI can be quite thorough and meticulous. Trunk space of a passenger vehicle is constantly checked. A CESAVESIN staff told me that drivers of freight trailers hide—or just "forget"—fruits for snacks in the space behind the driver's seat, or a small storage space right behind the door, which is an important inspection point (Figure 7-18).

On one hand, the significance of the stringent inspection of traffic is substantial. A SAGARPA official at a PVI revealed his experience of finding a few hundred fruit fly larvae in a few oranges he had seized from a passenger. Because a few hundred living larvae were more than sufficient to cause a grave outbreak in a PFA, intercepting such a significant amount of hazard directly contributes to protection of the PFA. On the other hand, more importantly in my view, the strict and often even annoying inspection at the PVIs, as with any inspection or surveillance (e.g., security check at an airport), would signal to drivers and passengers a normative expectation that all were to act in accordance with the regulation. By doing so, the inspection would function to "self-discipline" people such that the effectiveness and the efficiency of the regulation is maintained or even increased automatically. Chapter 9 will discuss such emerging normative effects of the regulation in detail. At this point, however, I highlight that as illustrated by these examples, the regulatory network to establish and maintain the PFA and the ALPP now extended its reach beyond farming areas.

Figure 7-17 Methyl bromide fumigation chambers at the federal PVI, "La Concha," in Escuinapa, Sinaloa, Mexico
This PVI is located near the state border with Nayarit. Host fruits without certificate must be disinfected before passing this point. (Photo by author)

Figure 7-18 Inspection of a commercial freight at the PVI "Las Brisas"
Small space (often used as storage of tools) behind the driver's door is an important inspection point. (Photo by author)

7.3 *Summary*

This chapter has reviewed how the Campaign against Fruit Fly has developed and operates as an AW-IPM. I traced research and development, and earlier attempts to establish PS measures in the field, rather than in packinghouses (i.e., post-harvest treatments). Some of the PS regulatory measures, for instance, the biological control using parasitoid wasps, began to be explored as early as the 1950s (when EDB fumigation had barely begun). Also, other measures, including SIT and research on basic biology (including physiology, behavior, and ecology), of the fruit fly pests were keenly conducted, while post-harvest treatments were becoming the principal PS measure to enable the export of Mexican mangos. It was not until the 1980s, when the EDB fumigation was banned and extensive investigations of alternatives to post-harvest treatment began, that outcomes of the accumulated research efforts gradually resulted in the basis for the Campaign, which was finally launched in 1992. Since then, the Campaign has demonstrated noticeable progress in establishing more PFAs and protecting them.

The review of the development of the Campaign as an AW-IPM program has illuminated several important features and themes to further investigate in the remaining chapters. First, the Campaign involves diverse and heterogeneous entities, whether humans and non-humans, including artifacts and other organisms. This association of these heterogeneous agents constitutes the complex network of regulation, which transcends spatial, institutional, and organizational boundaries. The legal foundation of the Campaign, containing mandatory rules, was buttressed with the hierarchical structure of statutes from the international standards to the national rulings. The regulatory network extends both “horizontally” and “vertically,” as it were, involving other governmental regulatory bodies (e.g., health department), and local governments.

Second, this regulatory network processes, or translates, uncertain and invisible phenomena taking place in the “natural” into the format compatible for further translation by using “inscription devices.” The inscription device converts invisible phenomena into visible formats, reducing the complexity in the field into a very simplified form. Results of the recurrent practices to suppress wild flies (e.g., biological control and SIT), which are hardly visible to humans, are converted by this mechanism into visible formats that make sense. Repeated mundane practices drawing distinctions between pest/non-pest (e.g., daily checks of traps, slicing sampled mangos, and identification of a trapped pest), although tedious, nevertheless secure the plausible assumption that the suppressing practices were working properly because their records constitute accumulated data, and eventually lead to the assumption that we “know” that a large geographical area is pest-free.

Third, these processes, which secure the knowledge that a certain area is pest-free (or in low pest-prevalence), are underpinned by ubiquitous monitoring of acts or behaviors of agents for quality control, and further by re-monitoring of the monitoring, namely, nested monitoring. For instance, the quality of sterile flies, or the competence of reproduction in the wild field, had to be secured and improved by the constant monitoring. Trappers monitor the pest, and are monitored by supervisors, for securing the quality of their practices. The monitoring serves to discipline acts of those involved in the regulatory network in accordance with the logic of PS regulations. While, as Foucault has made clear, disciplining through ubiquitous monitoring and surveillance over human acts is a necessary condition to increase productivity in any aspect of modern society infused with neoliberal political ideals, questions could be raised as to what rationale, logic, mechanisms, and scope of control, are presumed or employed to enact the discipline.

In this regard, my fourth point is important. The Campaign extended its reach from packinghouses to groves (i.e., orchard registration) to non-farming areas, and the disciplining effect also involved not only growers and packers, but also non-farming places and populations, including backyards of urban residents and passengers and drivers on highways. The regulation employed rigid physical settings, such as a bump at the PVI, which forcibly control movements of humans, as well as the thorough and stringent inspection that signaled the call for self-disciplining of those passing there. Thus, the regulatory network extended its reach beyond spatial, institutional, or organizational boundaries mobilizes actors and entities, whether human or non-human material beings, in “translation” processes, illuminating power exercised such that those actors act conforming to global regulations (Latour 1986).

My intention to reveal and discuss the working of PS regulations, including the Campaign for the export of Mexican mangos, is not to accuse or debunk it. From an agronomical and technical perspective, the Campaign is a surprising case of the application of complex, vast, meticulous, and fascinating human—and maybe non-human—ingenuities. If the Campaign successfully achieves its goals, many growers, especially those small-scale farmers suffering from lack of stable income sources, can benefit, as discussed in a later chapter. I hope that the descriptions and anecdotes above provide a glimpse of what is behind the globalization of agriculture and food, in which the Campaign is engendering orderings among people, things, and places, tacitly disciplining them to conform to the globally prevailing regulations. In Chapter 9, I will explore how senses of norm, moral, and values conforming to the regulation were emerging. In Chapter 10, I will specifically discuss whether and how PS regulations could really benefit small-scale growers. Prior to these chapters, however, in the next chapter I will further delve into roles and challenges of CESAVESIN as the key player in the Campaign under Mexico's particular political-economic backdrop.

Chapter 8

Engaging Humans and Non-humans for Control III:

CESAVESIN and New Actors

The previous two chapters have illuminated how the PS regulation network as material politics makes and maintains mangos and geographic areas pest-free. Among many actors, whether human or non-humans, engaged in this material politics, CESAVESIN is the most active and important actor. Its stated mission is: "To develop PS programs and strategies for prevention, control and eradication of agricultural pests and diseases, with trained and honest personnel and with professional ethics, offering a service of high quality in benefits for the farmers of the State of Sinaloa" (CESAVESIN N.d.). CESAVESIN is committed to not only the control of fruit fly pests, but also programs to control other agricultural pests and assistance to farmers and food processors to meet demanding standards and regulations to ensure food safety and quality, including GAP. Nonetheless, for CESAVESIN the campaign against *Tephritidae* fruit fly is the most urgent program. Its staff members are assigned to a variety of the PS activities delineated in the previous chapter, including biological control (e.g. release of sterile flies and natural enemies), mechanical and cultural control (e.g., elimination of host plants), and chemical control (i.e. pesticide spraying), inspection and registration of mango orchards, inspection of freight and passenger transportation, and detection and identification of the pest (e.g., trapping), in order to monitor, control, and eradicate fruit flies.

Concluding the three chapters examining how PS regulations have developed into a materially heterogeneous network and how that network operates, this chapter will elucidate specific roles played by CESAVESIN in the assembling of the regulatory network, as well as mundane operations of PS regulations. One vital insight about CESAVESIN's role is that this organization's "nature" as a hybrid, or multifaceted, organization mixing governmental authority with private farmers' organization, aptly mobilizes resources in a diffusive neoliberal political-economic climate. As detailed later, CESAVESIN is decreed as an organization of agricultural producers (farmers or growers) and simultaneously as an auxiliary organization of the Secretary of Agriculture under the current *Ley Federal de Sanidad Vegetal* (LFSV, Federal Law of Plant Health). Its unique status as a growers' organization and its virtual function as a government proxy allows CESAVESIN to make vigorous commitments to materialize the campaign against fruit flies in a distinctive neoliberal political-economic climate after the 1980s.

In the early 1990s, the federal government instigated enhancing the campaign by actively involving growers in the program. In 1992, the official program was launched as a campaign against fruit flies by a covenant signed by the federal and state governments and growers' representatives (Comisión Nacional de Sanidad Agropecuaria 1999). In 1994, LFSV was enacted with a clause that clearly decreed the CESAVE to be an organization of farmers as collaborators of the Secretary. In 1995, NOM-023-FITO-1995 was issued to establish the national campaign against fruit flies in which the responsibilities of growers in the operation of the campaign were clearly defined. Importantly, during the mid-1980s through the early 1990s Mexico was experiencing massive political, economic, and administrative reforms, making its way into a full-fledged free-market economy. In 1986, Mexico acceded to the General Agreement on Tariffs and Trade (GATT, predecessor of WTO) with the purpose of obtaining stable and secure access to the global market (Comisión Nacional de Sanidad Agropecuaria 2000). The North American Free Trade Agreement (NAFTA) took effect in 1994, the same year of the enactment of the LFSV. The law's enactment marked one of the crucial changes in Mexico's neoliberal reform to make possible the country's entrance into global economy. The founding of the CESAVE as an organization of farmers took place in the institutional and organizational transformation of Mexico's farming sector against this neoliberal political-economic backdrop. It is in this political-economic context that my analysis in this chapter situates significant roles of CESAVESIN in the campaign against fruit flies.

What was happening in Mexico's regulatory administration for farming sectors during the political-economic reform is in resonance with what I delineated in the review of literature (Chapter 2) as a governance shift and concomitant regulatory schemes. Although the term has broad connotations and hence oftentimes seems elusive, the governance concept has aptly captured broad changes in organizational and/or institutional structures through which the nation-state government has altered ways it intervenes in diverse aspects of people's lives, for instance, economy, social welfare, and resource/environmental management (Batterbury and Fernando 2006; Jasanoff and Martello 2004; Jessop 1998; 1999; 2002). One frequently discussed theme in the literature is neoliberal reform, which privileges: market mechanism, free trade, and an open economy; retreat, or changes in roles, of the nation-state in intervening economic activities as well as social programs; re-scaling of regulations including decentralization or devolution (i.e., granting regulatory authorities to local level government entities); reliance on and outsourcing to non-governmental/third-party/private bodies; and increasing use of accreditation, certification, and standard-making bodies. Drawing on

Foucault's arguments regarding governmentality, literature on governance notes, as ideological bases underlying these changes, a stress on self-help, self-responsibility, self-disciplining, and/or civic participation, which on one hand would allow more effective and efficient enactment of regulations, but on the other, tends to attributes responsibilities of handling problems to individuals (Barry, Osborne, and Rose 1996a; Dean 2007; Jessop 1995; Jessop 2002; Rose and Miller [1992] 2010).

In agri-food governance, in particular, these changes are schematically comprehended as presented in Figure 8-1 and Figure 8-2. The previous regulatory scheme (Figure 8-1) can be comprehend as one in which the nation-state government is the dominant, if not the sole, regulatory body, which covers various aspects of food production through retail in a commodity chain. Legitimacy of regulations would be strongly tied to legal authorities in governmental agencies. In the meantime, more recent, emerging regulatory governance can be understood as a more complex web of regulations, involving different types of entities. The "central" role of the nation-state government in regulation seems to have waned, or at least altered, as one part of the regulatory network. Emerging regulatory entities include, for instance, international regulatory bodies such as WTO, IPPC, and World Organization for Animal Health (OIE), transnational retailers and agri-food businesses, third-party non-governmental bodies that provide certification or accreditation services, and local governments. These entities, constituting a regulatory network covering the food commodity chain, employ non-legal-based norms such as private standards and certification, making it possible to control in detail conducts of people and objects (e.g., commodities), allowing global transactions of a variety of products.

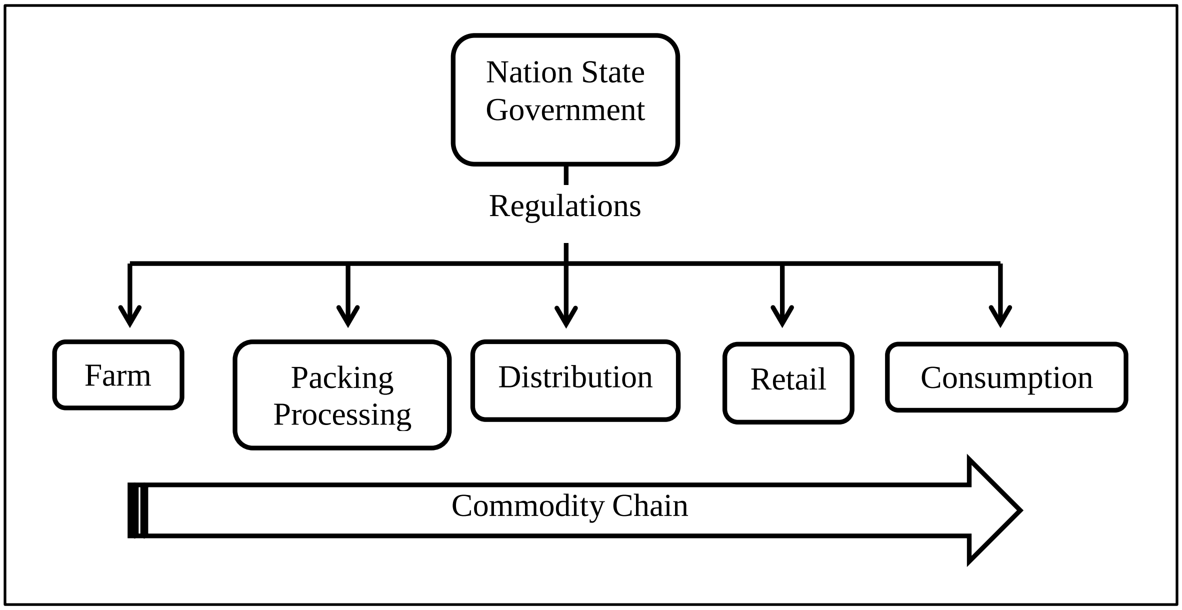

Figure 8-1 State-government-centered regulatory scheme over a commodity chain

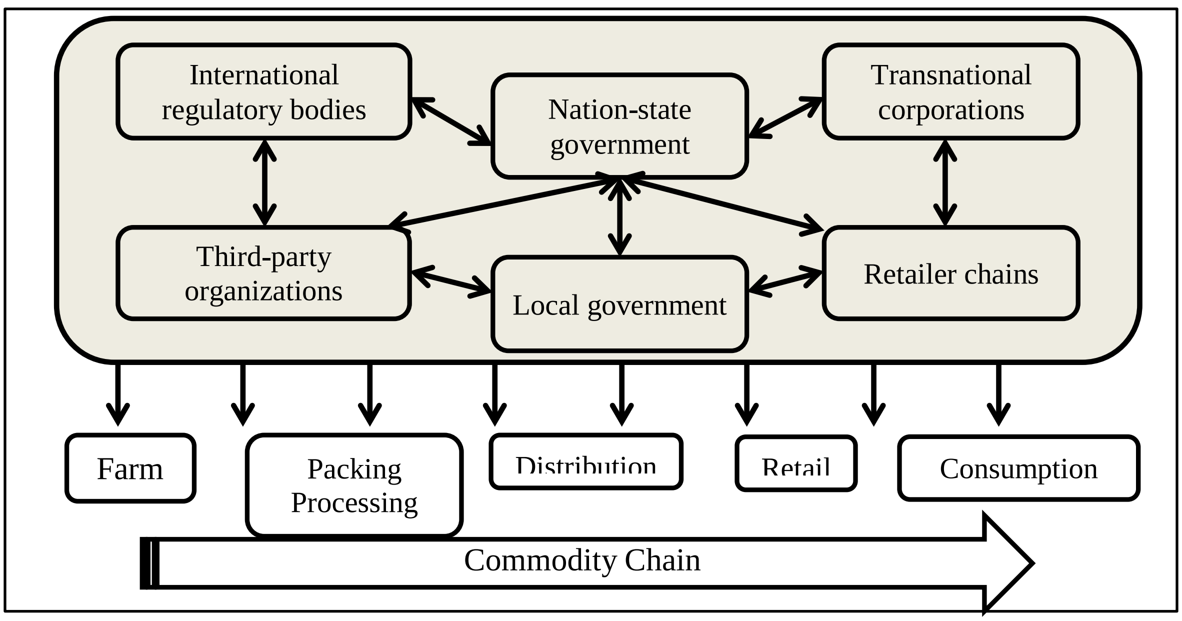

Figure 8-2 Multi-actor-based regulatory scheme over a commodity chain

With increasingly detailed norms or standards, a growing number of actors become involved in regulations; thereby the regulatory network (Figure 8-2) is becoming more diffusive and complex. The following analysis will illuminate how PS regulatory activities to control fruit fly pests by CESAVESIN and other non-governmental bodies have developed and are operated in a changing landscape of regulatory schemes under Mexico's neoliberal reform. In particular, my argument will center on their unique, multifaceted characteristics, which allow these actors to operate effectively in the increasingly diffusive PS regulatory network.

8.1 Roles of CESAVESIN

8.1.1 CESAVESIN as an organization of growers

CESAVESIN is one of 33 CESAVEs in Mexico (SAGARPA-DGSV 2008c). Each state has its own CESAVE. Despite its name, "*Comité Estatal* (State Committee)," a CESAVE is not a state governmental agency. The CESAVE is decreed as an *organismo auxiliar* (auxiliary body) of the Secretary of Agriculture of Mexico. Auxiliary bodies are defined in LFSV as: "Organizations of agricultural producers, which function as auxiliary of the Secretary [of Agriculture] in the development of the phytosanitary measures and of reduction of risks of contamination in the primary production of plants . . . ; and includes the State Committees of Plant Health [CESAVE] and the Local Plant Health Council" (Article 5). As this definition makes clear, the CESAVE is organization of farmers.

LFSV also includes as auxiliary body, *Junta Local de Sanidad Vegetal* (JLSV, Local Plant Health Council). JLSVs are organized as groups of farmers at the local level for which the CESAVE functions as a state-level umbrella organization. In terms of divisions of labor or degrees of involvement in activities between CESAVE and JLSV, there seems to be considerable variations among states. For example, in Chiapas, the southernmost state of Mexico, a JLSV was more active in fruit fly pest control programs than the CESAVE of Chiapas. In Sinaloa, however, although JLSVs were also quite active, it was CESAVESIN that served as the principal player in the contra-fruit-fly campaign.

Organizational involvement of growers in PS activities through CESAVE, JLSV, and its predecessors has a long history in the PS administration of Mexico. Under the *Ley de Plagas* (Law of Plant Pests), enacted in 1924 as the first plant protection law of the country, the government created local, state, and regional boards for a national campaign against locust, and used the term “auxiliary” as the denomination of these bodies for the first time (Gutieérrez-Peña 2000). In the *1937 Reglamiento de Ley de Plagas* (Governmental Ordinance for the Law of Plant Pests), CESAVE’s predecessor, *Comité Regional de Sanidad Vegetal* (Regional Committee of Plant Health), was established, and clauses for the *Comité* were retained in the two plant health laws enacted in 1940 and 1974 succeeding *Ley de Plagas* (Comisión Nacional de Sanidad Agropecuaria 1999; 2000).

Yet, until the 1990s, emphasis on *Comité Regional* as an organization of growers and its role in fruit-fly control programs were modest. The previous 1940 and 1974 laws defined the *Comité Regional* to be formulated by governmental representatives and other interested sectors (Bombín 1983; Gutieérrez-Peña 2000). When the ban of EDB as a fumigant in 1984 doomed the export mango industry of the state (see Chapter 6), CESAVESIN’s contributions seemed to be quite limited, too. Mango growers of Sinaloa formulated a committee to defend the mango export, in cooperation with the federal and state government, and launched a campaign against fruit flies in the state. Although CESAVESIN (as *Comité Regional* under the 1974 plant health law) was already involved in the campaign, most of the major pest control activities of the campaign (e.g., trapping) were undertaken by CAADES (a state-level organization of private-landowning farmers in Sinaloa) and other governmental agencies, rather than CESAVESIN (Anonymous 1986). It was not until 1992 that federal and state budgets were earmarked and transferred specifically to CESAVEs' operations of PS campaigns (Gutieérrez-Peña 2000).

Today, CESAVESIN explicitly presents its backbone as an organization of and for growers. One of CESAVESIN's senior officers emphasized the organizations' nature, that is, representing and serving growers: "We represent the growers . . . . The growers pay for us. The growers dismiss me." The same officer also stressed the importance of their participation, including financial commitment, as key to the success of the pest control program:

> If the growers don't invest, the campaign will have no results. Personally, I tell you, my experience, in the places where growers don't get involved in the campaign, where growers don't have interest, the campaign does not work . . . . The backbone [of the campaign] is that the growers commit themselves to the campaign, participate in the campaign, and yes, they finance the campaign . . . . That makes good sense. We have obtained excellent results. In a campaign where we have growers commit themselves and participate, we have achieved success.

To publicly communicate that the fruit-fly campaign was operated for and by growers, CESAVESIN printed a message on their vehicles (Figure 8-3): "*A Unidad Adquirida con Recursos de Productores de la Region*," meaning "unit acquired with resources of growers in the region."

Figure 8-3 CESAVESIN pickup truck with a note "Unit Acquired with Resources of Growers of the Region" in El Rosario, Sinaloa, Mexico
(Photo by author)

Underlying these discourses stressing the growers' commitment was the recognition that where growers took initiative, the campaign worked effectively. Such a call for growers' self-responsibility and self-reliance prevailed under the neoliberal climate toward diffusive governance over farming sectors in Mexico. A federal government officer's comment succinctly made this clear by attributing responsibility to individuals: "Growers themselves are responsible for expenses for pest control in their orchards." In addition, the federal government was taking the responsibility to control the pest in non-commercial farming areas, such as forests and urban residential areas. In this respect, the division of responsibilities in the pest control program between growers and the government was made clear in the official discourse.

However, the ideology stressing growers' self-responsibility did not guarantee their commitment. The above CESAVESIN officer stressed that the most difficult challenge for him had been to mobilize growers to commit to the campaign. CESAVESIN as an organization of growers seemed very apt to fill the gap between this ideological claim and the actual mobilization of growers. For more than several years, he had had a hard time convincing "disorganized" growers of the region and raising their consciousness about the significance of the campaign. However, though gradually and slowly, they became more interested and attentive to PS conditions of their orchards.

The attempt to involve more growers in the campaign demanded ingenuity to respond to their finicky demands. CESAVESIN had to offer a variety of services to draw the attention of growers with less interest in the pest control program. Some growers who had produced only mangos *criollos* (i.e., non-established local strains) tended to give less care to their plants because they were not eligible for the export program. Their orchards were prone to be spots of pest infestation, which would contaminate other groves and make all CESAVESIN and other growers' efforts in vain. To give such "disinterested" growers an incentive to pay more attention to their plants, CESAVESIN encouraged them to switch to a commercial variety, which would require more care yet sell at a better price than the *criollos.* CESAVESIN offered growers a free service of grafting to renew their orchards of *criollos* with a new variety. To facilitate the renewal of an orchard, CESAVESIN was helping growers eliminate *criollo* plants—yet not completely uprooting them but leaving their trunks to be utilized as rootstock—and then a contracted technician would graft shoots of a commercial variety on them. Also, CESAVESIN was providing assistance to resource-poor growers to clean up their orchards of *criollos*. I accompanied CESAVESIN's field operaton as part of mechanical control program for a mango grove. The grower had planted "Kent," a major commercial variety, but because of inadequate management, *criollo* rootstocks evetually overrode the variety. CESAVESIN staff members chainsawed unnecessary *criollo* branches, leaving only those of Kent. This helped the grower register the inadequately cared for orchard for export, which otherwise could be a problematic infection spot. Such attentive services, which might be hardly possible by a governmental agency, were conducted with the intention of building a "close atmosphere" with growers, according to a CESAVESIN senior officer. In an ideological climate after the 1990s impelling privatization and participation, CESAVESIN increasingly exhibited its strength as an organization of growers by providing services directly to its patrons.

Figure 8-4 CESAVESIN staff members cleaning an orchard in El Rosario, Sinaloa, Mexico
They eliminated only branches from criollo rootstock, leaving branches of a commercial variety. (Photo by author)

8.1.2 CESAVESIN as a proxy of government agency or self-sustaining "*negocio*" (business)?

In addition to its attribution as a "farmers organization," CESAVESIN had another significant character as a proxy of the government agency. As *auxiliary* of the Agricultural Secretary, CESAVESIN's personnel were engaged in inspecting cargo and passenger's baggage, and sampling, retaining, and testing (by destroying) products that were subject to the quarantine regulation under NOM-075-FITO-1997, which controlled transportation of fruit in the country (Figure 8-6). To my knowledge, it was quite unusual for employees of a non-governmental entity to be engaged in actions to seize a private property. In fact, the NOM-075-FITO-1997 as such had no clause to concede an official authority to inspect, sample, seize, or destroy fruits to the CESAVE (but it did authorize employees of the Secretary of Agriculture and Units of Verification of which I will discuss later in this chapter). CESAVESIN's de facto authority to seize fruits was based on its status as an auxiliary organization, and perhaps tacitly expected voluntary compliance of individual citizens to obey the regulation.

Figure 8-5 Inspection of luggage of passengers by CESAEVSIN personnel at PVI "Las Brisas," Sinaloa, Mexico
(Photo by author)

Figure 8-6 A CESAVESIN officer seizing a bag of oranges, subject to regulations at PVI, "Las Brisas," Sinaloa, Mexico
Later, all the fruits were tested for fruit fly larva. (Photo by author)

The status of CESAVESIN as a government's proxy could be validated with the fact that quite a few, if not most, employees of the organization were former governmental agents. The aforementioned senior officer, for instance, started his career in plant protection as a quarantine inspector of the Ministry of Agriculture at a federal inspection station. An officer currently working for inspection of cargo and passenger luggage at the checking point for the northern PFA in Sinaloa revealed that he had been an employee of *Compañia Nacional de Subsistencias Populares* (CONASUPO, National Company of Popular Subsistence). This former state-owned enterprise served to provide peasants with farming supplies and credits and was dissolved in Mexico's administrative reform that privatized or liquidated many governmental agencies. This officer also suggested that his colleagues of CONASUPO had gone through similar experiences, although I missed the opportunity to confirm with him that they were rehired by CESAVESIN or other CESAVEs. With its foundation in Mexico's reform adapting the nation to a global economy, CESAVESIN could be seen as a child of the age of neoliberal political economy. Although CESAVESIN hired staff members with no previous experience in a governmental agency as well, the presence of former governmental employees engaged in regulatory activities might be taken as another sign of its characteristics as the government's proxy.

In fact, the recognition of CESAVESIN as a governmental agency was frankly, yet sarcastically, reflected in a remark of a mango grower in southern Sinaloa: "CESAVESIN is an organization of the government. If there is no fly, there is no *negocio* [business] for them . . . . A governmental organization says what it wants. They charge what they want [i.e., campaign fee]." This comment implied not only CESAVESIN's functioning as a government agency, but also his perception that the organization had become a self-sustaining "*negocio*," which I translated as "business." Indeed, the recognition that CESAVESIN was engaged in a *negocio* was often heard among mango growers I interviewed. At least four of the interviewed growers, who were leaders of organizations of farmers in the region, explicitly used the term *negocio* to describe CESAVESIN's activities. For instance, a leader of a peasant group commented:

> I think, they [CESAVESIN] release [sterile flies] to the extent that the fly should still appear . . . drawing more money out. [Because] if the fly is gone, the *negocio* is gone . . . . We already think that way. Why can't they eradicate it? We now think that that [CESAVESIN] is *negocio*.

This sarcastic remark reflected frustrations widespread among mango growers of the region with CESAVESIN and the progress of its campaign against fruit flies. I could identify a couple of interrelated causes of the frustrations, reflected in these farmers' comments. First, though not shared by all the interviewed mango growers, there was a sense of distrust in governmental organizations and works in general. As I will discuss in more detail later (Chapter 10), until recently the Mexican political system had long been ruled virtually by a single party, *Partido Revolucionario Institutioinal* (PRI; Institutional Revolutionary Party). While the populist PRI ruling would deliver relatively generous social programs for the poor, the number of governmental agencies and state-owned companies and their expenditures had grown to the extent that led the nation to grave fiscal crises. Those who were critical of these monopolized, inefficient, and bureaucratized state enterprises might sense the same frustration with the operation of CESAVESIN as the government's proxy.

The second reason for the growers' frustration was that the progress in eradication of fruit flies in southern Sinaloa seemed stagnant or bogged down after the northern and central regions of the state were made free of the pest and the south was declared to be a low prevalence area. The above peasant leader condemned CESAVESIN's reiterated preaching that the pest would be eliminated soon, although in fact many years had passed with no—to his eyes—progress. He likened their situation to "being stuck in a sink" and "never able to leave from there."

The third reason, which was closely related to the situation as "in a sink," was that despite the sluggish progress in eradication, the fee for the campaign had continuously risen. As noted earlier, growers were committed financially to the campaign. They had to pay seventy pesos (approximately six dollars) per ton of harvested mangos to participate in the campaign. In the year of my fieldwork (2009), CESAVESIN in the southern area decided to raise the fee. Despite CESAVESIN's effort to save operational costs (see Chapter 7), expenses for field operations had constantly risen not least because of the growing mango production in the area. The rise of the campaign fee escalated the frustration of the participating growers, especially those small-scale peasant farmers. A frustrated leader of a peasant group denounced the way CESAVESIN was using funding resources: "Many growers, we, see CESAEVSIN, organization, you know, in the pickup truck of the year, good salaries, many employees and secretaries, much extravagance of resources, but . . . ask for more [money]. We also wonder . . . 'where is our money gone?'" And, his condemnation of CESAVESIN's pickup truck ironically recalls the message on the vehicle (Figure 8-3): "Unit acquired with resources of growers."

More importantly, however, the frustration was exacerbated by stagnant prices of mangos in the market. According to the interviewed mango growers and the CESAVESIN officials, the falling price of the mango market was recognized as the toughest challenge faced by them. According to a grower, when many farmers of the region began introducing mango as a promising export-oriented crop in the 1980s, its prices were about three pesos per kilogram, whereas currently prices were usually around 1.5 pesos, or sometimes even less than one peso, per kilo. As the number of farmers planting mangos increased, the supply (i.e., production) was getting saturated. Even worse, Sinaloa is the last to ship the fruit among the major mango producing states in Mexico, which would further depress prices. When growers of Chiapas, the most southern state, and followed by Oaxaca and Guerrero, begin harvesting fruits in January through February, prices would be three pesos or so. As the harvest proceeds toward northern states, including Michoacán, Colima, Jalisco, and Nayarit (right south of Sinaloa), prices would keep falling, and when Sinaloa's turn came in May or June, the price would hit the bottom. The stagnantly depressed price of mangos was increasing the sense of burden of the campaign fee for mango growers of Sinaloa. In the meantime, CESAVESIN was neither supposed to nor capable of directly manipulating prices of mangos, which is under the magical market mechanism. Under the swelling expenses for the campaign and fee payments supporting it, no difficulty was needed to imagine the desperation, frustration, or even rage, which led one of the interviewed growers to demand an alternative to the operation by CESAVESIN: "I think that everyone should be able to decide a private company that would do the job [of CESAVESIN]. Everyone should be able to choose freely a company which is more convenient."

8.2 Entry of New Players into PS Regulations

8.2.1 PS professionals, third-party and private entities

To this grower's eye, government agencies, including CESAVESIN as a proxy, seemed to attempt to monopolize the *negocio*, prohibiting entries by other private companies. However, the truth might be vice-versa. As noted, CESAVESIN itself had a façade as a private non-governmental organization. Moreover, the *real* federal government also was not only stressing the responsibility of individual farmers, but also promoting new types of entities to enter some parts of the PS regulatory network, such as *Profesionales Fitosanitarios* (PFs, Phytosanitary Professionals) and *Terceros Especialistas Fitosanitarios* (TEFs, Third-party phytosanitary specialists) both of which were accredited as authorized persons by the Secretary.

In PS regulations in Mexico, PFs serve as collaborators of the Secretary of Agriculture in the application of PS measures (Comisión Nacional de Sanidad Agropecuaria 1999; SAGARPA-DGSV 2008a). In a sense, PFs work to some extent as "free agents."[29] In the case of PFs contracted with CESAVESIN, for six months of the year (which constitute the mango harvest season), they were temporarily paid with the growers' campaign fees to dedicate time to check and verify commercial orchards; and for the rest of the year, CESAVESIN hired them with the federal government's budget to work for control programs in non-commercial-farming areas, including urban residential areas and forests. Employing "free-agent" PFs allowed CESAVESIN to allocate their

[29] As of 2011, 191 PFs were registered in the country according to SAGARPA-SENASICA's directory. While most of them belong to CESAVE or JLSV, some PFs work independently.

limited human and financial resources somewhat flexibly, depending on the source of funding, types of tasks, and seasonal variations in tasks.

Meanwhile, TEFs are external independent organizations or individual persons authorized by the Secretary of Agriculture as its collaborators especially in conducting evaluation of conformity with PS regulations (SAGARPA-DGSV 2008a). In essence, they are officially entitled to verify whether products or their production procedures meet certain PS standards set by the government. As of 2008, 491 individual TEFs (out of which 27 were in Sinaloa) were authorized to work in various PS regulatory activities,[30] and four corporate TEFs were authorized in verification and certification of regulated products such as mango (SAGARPA-DGSV 2008a).[31] In the case of the mango export program, they were working for inspection of harvested fruits in packinghouses and certification of registered orchards.

In LFSV, namely, the Federal Law of Plant Health, moreover, the Secretary of Agriculture can approve TEF as *Organismos de Certificación* (ODC, Organization of Certification) and *Unidad de Verificación* (UDV, Unit of Verification). ODC and UDV are decreed by *Ley Federal sobre Metrología y Normalización* (LFMN, Federal Law about Metrology and Normalization) to be private bodies accredited as capable to certify or verify conformity of products or procedures with regulations or standards. The PS authority of the Ministry of Agriculture of Mexico intended that all PS-related

[30] TEF's activities were not only in the mango export program but also in venues of other types of regulations and other commodities.

[31] These corporate bodies were registered as *Sociedad Civil* (Civic Society) or *Asociación Civil* (Civic Association), which are not established primarily for commercial, profit-making purposes.

certifications of products destined to domestic markets be handled exclusively by ODC and UD in the future (SAGARPA-DGSV 2008a; 2008b).

8.2.2 Privatization and decentralization in new legal frameworks of PS regulations

The entry of these new players in the PS regulations network was situated in the political-economic reform of Mexico during the 1990s to adapt to a global market economy. LFMN was enacted in 1992 with the objective to establish the fundamental rules concerning metrology, normalization (standardization), certification, accreditation, and verification systems in the nation toward "harmonization" with trade regulations under GATT (Comisión Nacional de Sanidad Agropecuaria 2000; Urrea-Salazar 2004). Under this law, all rulings, including PS regulations, affecting trade should be stipulated as *Normas Oficiales Mexicanas* (NOM; Mexican Official Rules), which are based on science to avoid unfair trade restrictions (Comisión Nacional de Sanidad Agropecuaria 1999).

Along with LFMN, LFSV constituted the essential components of the administrative reforms in the 1990s and afterward to adapt Mexico's national economy to a global free-trade regime (Comisión Nacional de Sanidad Agropecuaria 2000; Urrea-Salazar 2004). The 1994 LFSV represented significant progress in streamlining and deregulating the legal backbone of PS regulations (Comisión Nacional de Sanidad Agropecuaria 2000). The national PS authority responsible for this law, *Dirección General de Sanidad Vegetal* (DGSV, General Office of Plant Health) of SAGARPA, explained the law's intention (Comisión Nacional de Sanidad Agropecuaria 2000):

> a profound reorientation of the state involvement in assisting and providing services to the community, in a framework of shared responsibilities, based on the concentration of mutual commitments, as well as in the decentralization and deconcentration to transfer the functions and resources to the places where the production takes place, without neglecting the state responsibility in the PS matter. (16)

Accordingly, these new legal bases promoted decentralization and privatization of PS regulatory services; roles of third-party and non-governmental bodies were significantly increasing in the official PS regulatory scheme in Mexico. Thus, the introduction of the concepts of TEF, ODC, and UDV to PS regulations should be comprehended as a process of delegation and privatization of state authorities in the larger background of Mexico's political-economic restructuring to adapt to a global market economy.

The use of these private or third-party entities in the network of PS regulations could be justified with various rationales. According to a federal government official, one of the major administrative challenges for the federal PS authorities in the fruit fly control program was the shortage of personnel to cover all production areas, which resulted in the need to resort to private organizations. The same officer explained that third-party entities were introduced to PS regulatory activities specifically in the inspection of packinghouses with HWT and the certification of orchards to make the processes more efficient.

In addition, the rigor and transparency with which third-party organizations supposedly can work for regulatory activities would reinforce the justification of their involvement. According to the coordinator of the mango PS certification program of a third-party organization, a substantial increase in interceptions by the U.S. border inspection of fruit fly larvae in Mexican mangos in 2000 triggered the introduction of third-parties. As mentioned above, certainly the demand for private entities was primarily because of the dearth of government human resources. However, that was not the sole reason. Third-parties were expected to execute more rigorous inspection services. The coordinator emphasized, as the certifier's *raison-d'être*, its credibility supported by stringent implementations of regulations and standards. Even if one of his inspectors knew a farmer's hard work to grow mangos, the coordinator stressed, he or she would never pass the products if a single larva was detected. Since the Work Plan of the Mexican mango export program, elaborated by the Mexican and U.S. PS authorities, details the inspection procedures of shipped mangos, there is no chance of cheating or corruption. An inspector of the same certification body whom I met in a packinghouse in Sinaloa told a similar story, and added that, because of the rigorous demands the staff of the packinghouse had to meet, almost no one there liked him.

As with CESAVESIN's employment of PFs, the use of third-party entities in PS regulations seemed to postulate that it would make more flexible and optimal allocation of human resources possible. The certification organization I interviewed dispatches its 45 inspectors (all of which are TEFs) to mango packers from Chiapas to Sinaloa during the mango season. When less or no mangos are harvested, the inspectors work for other regulated crops such as avocados for export to the United States and potatoes. The government, operating under rigid budgetary and administrative constraints, would find it difficult to allocate its personnel for inspection of different crops of which productions, and thus demand for the inspection job, can vary among years. Of course, the personal lives of third-party inspectors working in different places become trying. The inspector I met in May in Sinaloa told me that he had taken no days off since January when he began working to inspect mangos in Chiapas. He had not seen his wife—he alluded that they had recently gotten married—until the previous week when she visited him only for a short time. Despite such grim stories, the PS regulation network engaging outside actors seemed to be working quite effectively and efficiently on the surface.

8.3 Complications of Neoliberal Marketization Reform

Mexico's neoliberal reform, which had resulted in apparently successful PS regulatory operations by private bodies, had also engendered some complications. As the reform had affected every aspect of administrations of Mexico, CESAVESIN was faced with an unusual and difficult challenge, which came from outside of the farm sector.
As explained earlier, the northern five municipalities were already free of fruit fly pests. On the highway running through the state, near the border of this PFA there was a PS inspection point (in the Mexican PS terminology, *Punto de Verificación Interna*, abbreviated as PVI, or in English, Internal Verification Point). All traffic entering the PFA passing through this point is subject to inspection by CESAEVSIN officers, and a regulated product must be abandoned, as shown earlier in this chapter. It is this inspection activity that protects the PFA from introduction of the problematic pests coming with traffic from other still "contaminated" areas. Furthermore, when I was conducting fieldwork, CESAVESIN was faced with an outbreak of fruit flies in the central region, which was recognized as pest-free by the Mexican government and was waiting for recognition by the United States. A senior CESAVESIN officer explained that complication in fact had been somewhat anticipated because, unlike the northern PFA, the central PFA had no PVIs at the border with the southern low prevalence area where

fruit flies were still detected. In the interview, he banged on his desk, perhaps expressing his frustrations, and insisted that CESAVESIN had to establish new inspection points.

At the time, CESAVESIN was negotiating with *Secretaría de Comunicaciones y Transportes* (SCT, Ministry of Communications and Transportations) to obtain permission to install two new PVIs. However, a couple of factors complicated the process. First, there were two major highways, including one toll road and one free (no-toll) road, passing through the central PFA; in contrast, only one highway passes in the northern PFA as the two roads from the south converge at the border at which the PVI Las Brisas was constructed (Figure 8-7). CESAVESIN had to convince SCT that two PVIs were necessary at the southern border of the central PFA to protect it. SCT would not be very happy to install two PVIs on the highways, because of its own policies to ensure high quality highway transportation, that is, convenience, comfort, security (safety), and time, which could be compromised by CESAVESIN's mandatory inspections.

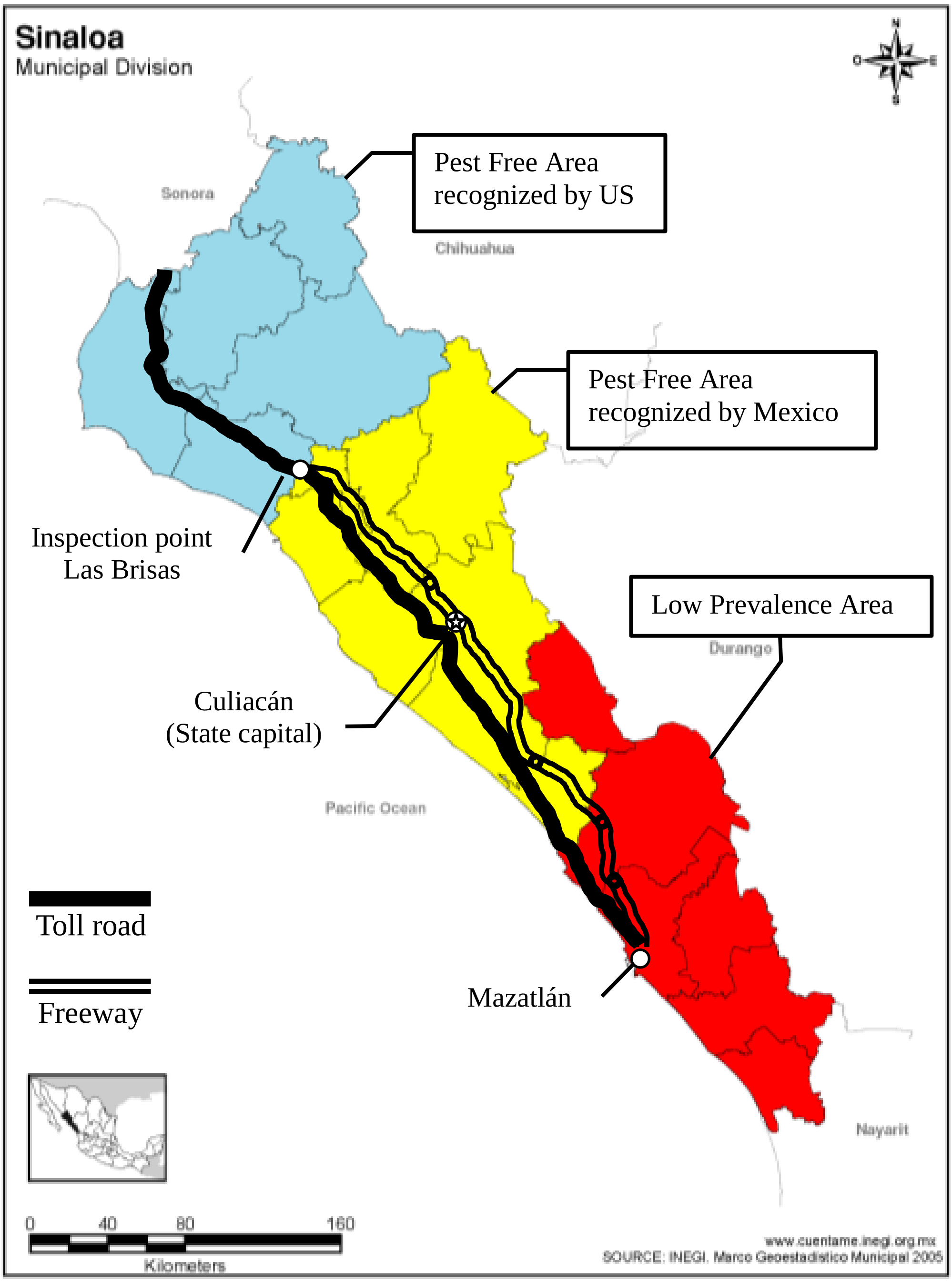

Figure 8-7 Pest prevalence status, locations of major highways and PVI in Sinaloa
Elaboration by author with a map image created by INEGI

Second, more importantly, part of the toll road between Culiacán, the state capital, and Mazatlán, the largest city in southern Sinaloa, was constructed with private investment funds. In Mexico, private investors can participate in bidding for investing in construction of certain sections of highways. This marketization of highway projects with private investments started in 1985 by a government facing fiscal shortage and unable to continue construction of roads on its own (Aguilar Quintero 2004).[32] Under this scheme, the government concedes to the bid-winning investor the right to finance construction and maintenance of a toll road section, and to receive returns from toll money collected from drivers. The involvement of private parties looking for financial returns arguably added complications to CESAVESIN's negotiations for the new PVIs, since SCT was under more pressure to assure the quality of highways, such as time and convenience, in order to retain drivers who as loyal customers were paying tolls, which were the basis for financial returns for investors. Although two PVIs have been successfully constructed on the two highways between Mazatlán and Culiacán by September 2011, this example indicated that as Mexico's neoliberal reform affected many aspects of lives of the nation, its consequences brought the PS regulatory network an unexpected "side effect" as it were.

8.4 Summary and Discussion

The previous three chapters (Chapter 6, 7, and 8) were intended to address the first research question: *How does the PS regulation network operate to draw distinctions*

[32] The Mexican government had a long history of engaging private constructers in highway construction and maintenance. What was remarkable about the 1985 reform was that it enabled full-fledged participation of private investments for return from collected toll.

between pest/non-pest, thereby enabling the export of Mexican mangos to the United States? Who and what devices, practices, or knowledge are applied in the development and enactment of PS regulations? Taken together, from the findings of the three chapters, important insights can be elicited to better understand transforming agri-food regulatory governance. Firstly, the network of PS regulations to allow the Mexican mango export has been becoming more complex and spatially and institutionally diffusive. When the Mexican mango export was possible solely with post-harvest treatment measures, such as EDB fumigation and heat treatments, the network of PS regulations centered mostly on the very process of the treatment. Although there were regulations applied to the outside of the treatment facility, such as orchard registration and shipping procedures, the scope of the regulations centered primarily on the very process to make the product free of the pest. Accordingly, a *dead* fruit fly larva intercepted in a mango detected by the U.S. border inspection was not problematic even if it indicated that the orchard or the area of origin might be infested (note however, the newly approved irradiation treatment has changed this, too). In the "post-harvest-centered" scheme since 1945, until recently when third-party bodies took responsibility for inspecting harvested mango fruits in packinghouses, relatively few types of actors, such as Mexican and U.S. PS authorities and the packers and exporters association (EMEX) were engaged.

However, as the technical scheme of PS regulations shifted toward the "area-wide" approach, more specifically, the Campaign against fruit flies, consisting of biological control, sterile fly technique, establishment of quarantine *cordones* and PFAs, and monitoring orchards and harvesting and shipping processes, the whole PS regulatory network expands itself and creates more points of regulation. In addition, newer post-harvest measures also have become diversified. Now, besides the conventional heat treatments (i.e., VHT, HWT, and FHAT), irradiation can also be applied to mango fruits and other fruits (e.g., guava). With insights from systems theory and ANT, it can be argued that the whole regulatory network has become increasingly complex, and materially heterogeneous, including (sub-)components, and become more diffusive in that control points spread spatially and institutionally. These newer PS measures tend to be increasingly reliant on non-human inscription devices and increasingly *less* reliant on human direct perceptions. Engaged in the regulatory network are, for instance, traps, GPS, irradiation dosimetry devices, and heat sensors and loggers (already used in HWT). Also, although conventional human-sensory inscription devices, such as eye, nose, ears, and hands, might still play significant roles, it seems the importance of monitoring, documentation, and recordkeeping activities throughout the regulatory network has risen to an unprecedented degree to secure traceability by compensating human direct perceptions. In the diffusive regulatory network, the scope that each control point regulates may be relatively limited. Just as Law and Mol (2008) highlighted in conceptualizing material politics, the PS regulation network to draw distinctions between pest and non-pest are enacted and sustained through very mundane, day-to-day practices; and what enables the entire regulatory network to work is the incessant monitoring by nested monitoring (i.e., monitoring of monitoring). The next chapter (Chapter 9) will highlight how this nested monitoring as well as mundane practices beyond farming areas engendered normative behaviors and moral and professional values, which served to discipline humans, and in some cases non-humans, to act in accordance with global PS regulations.

Secondly, in line with the recent literature in agri-food studies, the diffusive regulatory network involves not only the state national government but also new types of organizations with the nature of a hybrid composed of private and state authority, including CESAVESIN and private or third-party entities (Hatanaka, Bain, and Busch 2005; Higgins and Lawrence 2005a). As this chapter has just explored, the roles of CESAVESIN as an organization of growers and other private, third-party organizations has risen in enacting the regulations to make possible the export of Mexican mangos to the United States. Although Mexico has a long history of farmers' organizational involvement in official pest control since the 1920s, it was relatively recently, that is, in the early 1990s, that CESAVESIN as a farmers' organization fully started to mobilize growers in the campaign against fruit flies. With its multifaceted or hybrid characteristics, CESAVESIN has been aptly managing the pest control program operations in the middle of Mexico's neoliberal reform where discourses pushing privatization, decentralization, civic participation, or self-responsibility have prevailed. On one hand, as an organization of growers (i.e. as a private entity), CESAVESIN has been successful in mobilizing mango growers in the region. Although there were dissatisfaction and discontent with its performance among growers, CESAVESIN's achievements seem to be buttressed by and resonating with the prevailing neoliberal discourse that stresses self-help, self-responsibility, and participation. On the other hand, with its façade as a governmental proxy and staff members who had experience and skills in regulatory operations, this organization has continued exercising substantial de facto authority and strict regulations to protect the PFA and promote eradication of the pest.

Although CESAVESIN has played vital roles in the regulation, other new entities have become important in the PS regulation network. Engaging new actors such as PF and TEF (and in the future, more active involvement of ODC and UDV) has enabled more flexible and optimum allocations of budgetary and human resources as per work needs. Also, these entities have been supposed to offer more rigorous and transparent operations of regulations. Discourses to promote downsizing of governmental agencies supported the introduction of these new entities into the PS regulation. The emergence of CESAVESIN and these new entities indicate—regardless of however successful it has been—Mexico's struggles to adapt to the global, open-market economy since the 1980s.

Thirdly, as the PS regulatory network has spatially and institutionally extended, it is very likely to encounter other institutions or social systems, just as demonstrated by the above case of highway administration. With insights from systems theory and ANT, it can be argued that different networks or systems should have distinctive interests and/or operational programs. Extension of a network (e.g., PS regulations against fruit fly pests) may be faced with complications or obstacles resulting from different interests and programs of another network. A distinctive system (e.g., highway administration) can respond to the other system (e.g., PS regulations) either if the former does successfully incorporate (or translate, in ANT terminology) the interest of the latter, *or* if its program is not disturbed by the latter. In the case I have demonstrated, SCT would agree to construct the new inspection points *only if* it is convinced that its criteria, such as convenience, comfort, security, and time, are not compromised.

In some cases, moreover, a system might not react to outside forces or organizations at all, and thus two different systems or networks may have no chances for negotiation. The PS regulation network was not designed to control mango prices in markets but to kill or eliminate fruit fly pests. Whereas falling prices of mangos was lamented, the growers and CESAVESIN's senior officers did not consider that PS regulations as such would be able to intervene directly upon the mango market. On the other hand, the market, as far as it is believed to operate based on the balance between supply and demand, does not seem to be responding to PS regulations. Indeed, the very source of the frustrations spreading among the growers was the fall of mango prices in the market, which beyond CESAVESIN's control. Indeed, high prices of mangos were—whether tacitly or explicitly—underlying the justification for encouraging growers to participate in the costly campaign against fruit flies. Better prices of the commodity were supposed to compensate the investment by mango growers. The last finding chapter (Chapter 10) will examine in detail whether or how this expectation will be fulfilled.

Finally, it seems to me ironic that while more and more stringent regulations have been applied to enable the export of mangos, the neoliberal political-economic reform has left prices of the products out of the regulations. Neoliberalism has been the subject of heated debates in the social sciences, which have exposed its contradictory nature (Harvey 2005). The irony between the tightened regulatory governance and the loosened market can be comprehended as an indication of such contradictory nature. This ironic consequence also resonates with another dimension of the irony of neoliberalism, that is, the call for self-help, self-responsibility, and participation. Such discourses make it very "natural" to assume that every farmer is responsible for his/her own farms. If my soil and fertilization management was poor and my mango trees gave a poor harvest, I would be responsible for *my* poor harvest. The consequence is mine. However, if my pest management was poor and let fruit flies thrive in my field, the consequences would affect other people as well. Pests in my orchards would expose my neighbor orchards to dangers of contamination by flies from my field, and indeed if one of them was contaminated, its fruits could not be shipped. Therefore, the call for self-responsibility, attributing consequences to individuals, in fact tacitly demands a collective responsibility. In essence, every *individual* grower of a global commodity under stringent regulations, such as the mango, is *collectively* responsible for not only his/her farm but also the farms of other growers. The next chapter will highlight how this hidden call for collective responsibility, tacitly underlying the discourse of self-responsibility, engenders a sense of morality among growers.

Chapter 9

Emerging Norms and Smoldering Conflicts

The previous three chapters have delineated the actual operations of the PS regulation network to enable the export of mango fruits (and potentially other host fruits). In essence, what PS regulations accomplished was to draw the boundary between pest/non-pest as to mango fruits, mango groves, floors in a packinghouse, or large geographic areas, by engaging diverse agents, including humans and non-humans. The regulatory system also established itself as a social network with its growing internal complexity involving more and more components to secure control over every aspect of the process to make mangos pest-free. This regulatory network consisted of mechanisms for monitoring and re-monitoring, which functioned to discipline actors to conform to the regulation. Once a boundary was established, it kept enacting itself through controlling and disciplining acts of human and non-human. The regulatory network extended spatially and institutionally its reach from the site of mango production (i.e., groves) and processing (i.e., packinghouses) to things, geographic areas, and people that were not directly involved in the production of the host fruits.

This chapter will turn attention to analyses of, first, how associated values, normative expectations, and moral senses, as well as disorder and conflict as attendant corollaries, emerged in the process through which the PS regulation network extended its reach. The extending network was not merely making distinctions between pest/non-pest. As presented earlier, the regulations entail a nested-network of monitoring, which serves to self-discipline actors. Such self-disciplining mechanisms engender values, norms, or moral commands that could guide or even bind acts of humans and non-humans. Yet, even if PS regulations successfully established certain guiding principles, they would by no means guarantee that all actors act in the way the regulation commands. Rather, they could be discontent and disobey the rulings, or even conflict with those who are deemed to be making or enforcing the regulation. One may want to call a situation where discontent, disobedience, and conflict prevails, “disorder,” in contrast to the orderings which the regulation as material politics was designed to establish and maintain. However, in my view, some of the essential concepts, such as values, norms, and moral expectations, as well as (social) order, disorder, and conflict, need careful consideration to be able to guide my analyses of socio-material orderings in contrast with disorder. In what follows, therefore, I will provide clarifications of these key concepts, followed by analyses of empirical cases guided by them.

9.1 Emerging norms

9.1.1 Interrelation of values, norms, and morals emerging from regulations

Regulations or standards endorsed by scientific knowledge have associated values, normative expectations, and moral implications, although the scientific community may pretend otherwise. Scholars of STS have been concerned with how science serves to make and legitimate boundaries as classifications of things and people, and about the social implications of classifications. As exemplified by such categories as diseases and certain race/ethnicity groups, people categorized in a particular way can be subject to exclusion from society (Bowker and Star 1999). In a similar vein, scholars in the sociology of agriculture inspired by STS insights have revealed that commodity standards as a means of classification, legitimated by science and technology, can not only standardize products to facilitate market circulation of the products, but also classify people engaged in production into such categories as “good famer” and “bad distributor” (Busch 2000; Tanaka and Busch 2003). While products that meet standards and individuals producing them are allowed to sell in the marketplace, those that fail to meet the standards are likely to be excluded and thereby lose opportunities to gain from the market. Thus, for STS scholars, the control through allegedly neutral scientific knowledge unquestionably raises sociologically pertinent consequences such as associated values, norms, and morals.

To clarify analysis, however, I posit distinctions between values, norms, and morals, which constitute three interrelated layers: first, values, which communicates asymmetrical importance resulting from preciousness of things, acts, or humans; second, norms, which communicates commanding acts pursuing a (positive) value; and third, morals, which communicates esteem and disrespect to the whole personality of a human. The PS regulations in the present study served to control and/or discipline acts of growers, packers, and transporters or those involved in the production and/or export of mangos or other host fruits. In doing so, the regulations not only draw lines between pest/non-pest, but also generate value-laden distinctions between good (or, right, well) and bad (or, wrong, poorly): if a grower does manage to control pests well, he/she is deemed a good farmer. Values as corollaries of the regulations can further generate normative expectations, which call for acts or thoughts in line with the “positive” side of the values (good, right, or well): a farmer *should* complete *right* pest control practices. Furthermore, the call for conforming to the positive values can, but not necessarily, result in a moral judgment regarding a person: a grower who enacts right practices regarding pest control is a good farmer, hence also a (morally) good person.

Notably the first (i.e., values) and the second (i.e., normative expectations) can apply to not only humans but also non-humans (e.g., "a McPhail trap is poor in capturing wild fly populations correctly" and "a sterile insect should be capable of mating a wild fly"). On the other hand, the third layer, the moral, seems to apply only to persons; and more importantly, it tends to pertain to the esteem of *the whole personality*, rather than specific aspects of a person (Kneer and Nassehi 1995). In other words, when we think that a farmer is not simply a good farmer but morally good as well, it is likely that the judgment implies that he or she has a good reputation in other, if not all, aspects of the person. The above considerations will guide the following analysis of values, norms, and moral judgments emerging from PS regulations.

9.1.2 Growers' morality

As noted above, PS regulations not only stipulate explicit standards of practices to carry out in an orchard, but also establish implicit standards on values of acts and the personality of a grower. In field expeditions with personnel of the PS authorities (i.e., CESAVESIN and USDA-APHIS), oftentimes I heard their comments or evaluations on conditions of mango groves we visited. In an orchard in the northern PFA, where ripe but unharvested fruits scattered on the ground, an APHIS official told me that "this would be really problematic if this was in the southern ALPP like Escuinapa" because growers in southern Sinaloa would have to collect and dispose of unharvested fruits. Besides, in the field trip for mechanical-cultural control, which I described in Chapter 8, a CESAEVSIN technician grumbled about conditions of the orchard under poor management practices. For example, to allude to the lack of adequate orchard management, the technician explained about "witch's broom" (a plant disease that causes abnormally dense shoots and eventually weakens the infested plant) being rampant in the orchard. Also poor maintenance allowed shoots of the *criollo* rootstock to dominate branches of the Kent, the grafted commercial variety. Although the disease and the overriding rootstock as such did not necessarily indicate the lack of the required fruit fly control, it evidently demonstrated lower-than-average quality of overall farming practices. Whether problematic or poor orchard management, the comments implied value judgments regarding the practices of the grove owners or even the personalities of the grove owners. And, the value standards could lead to the emergence of normative senses that called for responsibilities of growers not only at the individual but also at the collective level.

In the previous chapter, I discussed that while there was a call for individual responsibility at an individual orchard, there was an underlying exigency for collectively bound responsibilities. As per the provisions of the NOMs for the Campaign, every mango grower to export the fruit had to practice required measures *individually* on her/his grove, including burying fruits in the ground, eliminating weeds to prevent fruit flies from hiding there, and cleaning up trees by pruning. However, as fruit fly pests are highly mobile, a grove under inadequate pest control provides them with refuge and becomes an infestation spot from which insects contaminate other groves, as made clear in an interview with a leader of a JLSV in state other than Sinaloa:

> I personally register my grove for export to obtain better prices. To carry out control of the fruit fly, however, I am surrounded by *burros* (thickhead) growers who do not do campaign [i.e., control practices], who have no interest, who [nonetheless] sell their fruits in any ways. They don’t do campaign but affect me enormously. I can’t control the fly in my own grove because I am surrounded by *burros* . . . . And the same happens to all of us who have registered for the export program. . . .

Thus, the responsibility surpasses the individual matter but becomes a collectively binding norm. Every *individual* farmer is responsible for his/her grove to *collectively* prevent flies from spreading from to other groves. Yet, according to the same leader, this collective norm was not underpinned as a mandatory practice by any legal statute; or more accurately, although there was a NOM that stipulated rules to prevent infestation spots from occurring, they were not effective nor applied sufficiently to impose individual growers to adopt specific practices.[33] In this specific context, the state authority seemed very shy about intervening in individual practices for pest control, perhaps to safeguard the belief in the individual freedom at his/her tract under liberalist (including neoliberal) premises.

Accordingly, officials of the PS authority including the auxiliary body opted to resort to normative senses that could collectively bind individual acts. Another officer of the same JLSV explained:

> SAGARPA told us, 'You have to make the growers have consciousness and conscience, and convince them.' SAGARPA has the authority to register the packers for national markets as well as for export because it issues the certificate for transport of fruits. I make the grower conscious because there is no law to obligate [rules].

The phrase "made the growers have consciousness and conscience" was my translation of "*concientizar al productor*." Unlike English, Spanish makes no distinction

[33] NOM-081-FITO-2001, *Manejo y eliminación de focos de infestación de plagas, mediante el establecimiento o reordenamiento de fechas de siembra, cosecha y destrucción de residuos* (Management and elimination of spots of pest infestation through the establishment and rearrangement of dates, harvest, and destruction of residues), is the decree that has statutes commanding actions for prevention of infestation spots. This NOM was decreed independently of NOM-023-1994 and NOM-075-1997, which primarily govern the Campaign.

between consciousness and conscience in the term *conciencia*. Likewise, the verb *cocientizar* means to make someone conscious and conscientious and hence already has a normative connotation. Moreover, the fact that this officer's anecdote resonated with the senior officer of CESAVESIN, who struggled to raise consciousness (and conscience) among the local growers, indicated that, to solve the paradoxical calls for the individual responsibility and the simultaneous collective responsibility, the PS authorities took recourse to raising normative senses among growers.

The call for consciousness and conscience, however, and of course, had not resolved the problem of growers' non-compliance to the rules. Then, such growers being unwilling to abide by the regulation became subject to moral judgments, especially condemnation by other growers who observed the rules. In the interview quoted above, the leader of JLSV explicitly called his fellow growers who did not perform the required practices "*burros* (thickhead)."[34] The word *burro* was not simply meant to criticize some attributes of a person, but rather directed to his/her inclusive personality. In other words, such a morally condemned person would be deemed prone to commit other wrongdoings. The above JLSV officers indeed alluded that those who were not practicing the required measures were engaged in other delinquencies, such as cheating of certificates to smuggle fruit through intermediaries especially to sell to national markets, which required less rigorous controls. It was such loose, or even nearly unlawful, marketing channels that fed a vicious circle: growers could sell fruits to buyers, even if their prices were low because of poor management; buyers would buy fruits at lower costs even if

[34] In addition to "thickhead," *burro* means donkey, which perhaps provoked the former connotation.

fruits might have blemishes because of poor management. For those who were in this cycle, the required PS measures against fruit flies would be of the least importance. The above JLSV officer expressed quite explicitly his frustration with such a situation, which he called “*disorden* (disorder).”

Meanwhile, understanding moral evaluations as attribution of esteem or disesteem to the whole personality, I argue that a moral condemnation toward a whole personality could conceal, behind the condemnation, varying circumstances, including local-level political, financial, or cultural backdrops, in which each grower’s livelihood was enmeshed, thereby, especially when there was a plausible reason for non-compliance, making it more difficult to solve these problems. As I will discuss in the next chapter, while the rationale for growers to participate in the Campaign (which requires expenses) had resided in the prospect that prices of mangos would remain high, scrutiny would be needed as to how farmers with varying financial and technical resources would perceive such an optimistic prospect. If this prospect does not appear to be the case to a grower, he or she would be plausibly unwilling to make a commitment to the Campaign. Nonetheless, if a moral condemnation is directed to such a grower, it is likely to ascribe the non-compliance to his/her personality while obscuring the plausible reason for non-compliance.

My point to conclude the present section is that recourse to morality to ensure or encourage growers to participate in the PS program be taken prudently. On one hand, the call for moral obligation serves to fulfill the lack of secure legal endorsement (with sanction, for instance), which would urge growers to engage in necessary pest control practices. In essence, it is a functional equivalent for the legal binding force. On the other hand, by ascribing problems to the whole personality, rather than plausible reasons behind non-compliance, a moral call can make it difficult to solve the problem.

9.1.3 Emerging normative senses outside of mango production: "I wish everyone were like that."

As reiterated, the PS regulation network enabling mango export was extending its reach out of the mango export industry. Once a boundary was established and maintained through mundane practices, it became capable of controlling human and non-human acts legitimately and more securely. PVIs installed throughout the country monitor traffic of plant products. At the PVI on the border of the PFA in Sinaloa, everyone and all cargo passing there had to be inspected. Fruits subject to the regulation, whether of commercial cargo or of a bus passenger, if undocumented, or even some garden trees under the control, would be spotted, confiscated, inspected, and destroyed. In this section, I will illuminate how norms emerged among those who were not involved in mango production through these extending regulatory activities.

As demonstrated in Chapter 7, CESAVESIN technicians worked in not only sites of production of mangos and other host fruits, but also in places that are not directly involved in production or export of the fruits. Their expeditions for the Campaign operation included spraying of bait-insecticide mixture and elimination of non-commercial host fruits. The extended regulatory actions would logically entail interactions with people who were not engaged in farming, let alone, production and/or export of mangos. Such interactions, revolving around PS regulations, could provoke senses of judgment as to if people, things, or their acts were in accordance with rightness or wrongness provoked by the regulations. And a right or wrong distinction might further be underpinned even with a legal basis. For example, carrying host fruits with no certificate into a PFA could be illegal hence subject to sanctions. In the cases of mechanical-cultural and chemical control in urban areas, a sense of rightness or wrongness about an act would not immediately corroborate with the legal/illegal distinction. This is because the NOMs that command the Campaign did not explicitly warrant sanctions even if non-farming citizens do not let CESAVESIN spray or cut host trees in their backyards. Even if a household owner refuses to cut down a host plant tree, CESAVESIN could not punish or reproach him/her for the uncooperative attitude, and instead it had to train its personnel to be polite in interactions with such non-farming citizens to maximize voluntary cooperation. Still, in the fieldwork I witnessed scenes where certain normative expectations were emerging as to how even non-farming people were expected to act in accordance with the regulation.

In an expedition for spraying in a township, when a senior CESAVESIN technician and I in the pickup cabin were waiting for another young technician to finish cleaning up the equipment, a woman approached us and said that she had heard that CESAVESIN would help to eliminate problematic plants. She had a couple of host trees in her backyard, and wanted to eliminate them because they had grown too large to handle. With no reason to refuse such an obliging offer, the technician discussed with her to schedule a visit of a team of technicians to eliminate her trees. After she left the vehicle, when the young technician completed his task behind the cabin, the senior technician, pulling out the vehicle, said to me—or to no one—with a slight sigh, "*Si todos fueran asi*" meaning, (I wish) "if everyone were like that" (cooperative).

This anecdote bears striking significance as an example of the emergence of normative expectations, which were not yet explicitly decreed as a legal statute or a specific moral code, nonetheless involving actors in values in accordance with the global regulations. The woman might just want to take advantage of the Campaign to eliminate the annoying trees on her property and obviously did not have any obligation to collaborate with the regulations or the mango sector. While one may think that where there is a regulation it is natural to think that people should observe it or cooperate with it, she did not have any reason to do so. Putting aside the question of whether such an attitude is "natural," what drew my attention was that I was witnessing a moment when a normative expectation was emerging, creating social orderings at the local level, yet conforming to the global regulations. That was a moment when the global began enacting itself at the local. If the PS regulations network was to further extend its operations in non-farming areas and therein apply more stringent control measures including legal statutes,[35] then stronger normative or even moral expectations might emerge. As witnessed in the above case of the JLSV officers, a moral condemnation towards those who do not observe rules is prone to be an attack on the personality, rather than specific circumstances that cause the non-compliance, and hence tends to provoke otherwise avoidable conflicts.

[35] Many local governments of municipalities in Japan where Asian pears are grown have ordinances that prohibit planting of juniper, a host for *Gymnosporangium* (a fungi), which devastates pear fruits, within the municipal territories, whether in production sites or backyards.

9.2 Smoldering Conflicts

As demonstrated so far, while the PS regulation network was generating orderings of humans and non-humans, it was also the case that behind the apparent orderings, as the officers of JLSV lamented, "disorders" seemed to be prevailing among those who were involved in the regulatory network. In this section, my analysis will center on disorders surrounding PS regulations, and conflicts as its corollaries. As I posit that the PS regulation network constitutes a field of (material) politics, and that politics is enacted by actors competing for dominance in a field, it is realistic to expect "disorders," including discontent against, disobedience to, or conflicts with, the dominating PS regulations. In the meantime, while the concepts of "order" (and its opposite, disorder) along with "conflict" are frequently discussed themes in sociology, oftentimes I have had difficulty grasping what they denote. In what follows, I will delve into these concepts, while demonstrating empirical cases of disorderliness and conflicts I detected throughout the fieldwork.

9.2.1 Order and conflicts

Before demonstrating my empirical observations from the fieldwork, first I will provide theoretical considerations of disorderliness and conflicts. In sociology, order or orderliness of society is often associated with solidarity based on consensus, conformity, or obedience to norms or morality. Conflict theorists (e.g., Dahrendorf 1959) countered such views that look to consensus as the basis of social orderliness. Then, in sociology, the concepts of consensus-based order and conflict in society seem to be oppositely juxtaposed (Nagaoka 2006). Indeed, more generally, disorder can be defined as (1) lack of order, (2) breach of the peace or public order, and/or (3) abnormal state of body or mind (The Merriam-Webster Dictionary s.v. “Disorder”). These categories indicate the layered interconnections between disorder (i.e., lack of order), conflict (i.e., breach of peace), and disturbance to a “normal” status of human mind and body.

In the meantime, however, my study drawing on social systems perspective and ANT (Castellani and Hafferty 2009; Law 1994; Luhmann 1995), which are indebted to complexity theory, might provide a slightly different, though not incompatible, perspective to understand order and conflict. According to these theoretical perspectives, in which the order(ing) is understood in relation to the complexity, that is, selecting from vast alternative possibilities, order is a status where particular patterns of selection are more likely to occur than other possibilities; disorder then would be where particular patterns of selection are less likely to be observed. This “order(ing)-as-selection” perspective challenges the more commonly (yet implicitly) accepted, opposing juxtaposition of order and conflict. The conflict as such is not an opposite of the order, but rather a particular type of social order(ing), while order(ing) does not only mean consensus nor conformity to norms or morals.

Rather, following Luhmann (1995), I define a conflict as mutual rejection of claims by other parties. In essence, in a conflict situation, one acts to express “No” to a previous act or communication. Being constituted as a chain of rejecting acts, therefore, a conflict *per se* indicates *orderliness* in the sense that it is relatively stable, cohesive, and predictable.[36] However, I also should note that conflicts often occur with physical or

[36] In a similar vein, “deviance” and “crime,” which are also oftentimes deemed as antitheses to (social) order, can be deemed as a particular social order, that is, continuously enacted acts against expected norms or morals.

mental violence and disturbance. Perhaps that is a reason why the conflict concept is oppositely juxtaposed with order. Still, I distinguish, from a conflict *per se*, physical and social disorder such as destruction of economic property caused by a physically violent conflict (e.g., a war), and deem them as (lamentable) corollaries of the conflict. Thus, to avoid confusion of disorder with conflict, distinctions should be drawn between (1) conditions that potentially provoke conflicts, (2) conflict as a coherent chain of acts communicating rejection (Luhmann 1995), and (3) "negative" corollaries that a conflict provokes, such as disturbance to other social networks and/or the human mind or body.

The PS regulations the present study examines were indeed rife with potentially conflicting conditions. For example, as the principal scheme of PS regulations was shifting from HWT to establishing PFA, some well-off mango growers and packers might be more willing to adapt themselves to the new scheme, while others with less capital might be unwilling. Then, it was anticipated that there would be conflicts or discontents concerning PS regulations among the PS authority, growers, and packers. As the economic prospect opened by PS regulations, and discontent with it, will be discussed as the key theme in the next chapter, in what follows I will focus on cases where I heard about confrontations between packers and personnel of the PS authority engaged in the inspection of fruits prior to the HWT processing in a packinghouse.

9.2.2 Tensions and conflicts in packinghouse

The Work Plan, which details procedures and specifications of post-harvest treatments, and NOM-075, which controls transportation of host fruits, demand that personnel of authorized certification bodies and USDA officials be stationed in a packinghouse for inspections of fruits harvested and brought from fields. Hence my field observation revealed that packinghouses were sites where different social (institutional and organizational) networks with varying interests would confront one another; their conditions were prone to potential conflicts. For instance, in one of the packinghouses I visited in Sinaloa (southern ALPP), its personnel, especially their manager-level staff, were under pressure to process (i.e., disinfect fruits by HWT), pack, and ship fruits as soon as possible, because if they were to increase their sales, they cannot let fruits purchased from growers perish, and they want to finish their work and go home early. However, two officials, one hired by USDA-APHIS (a Mexican national) and the other from an authorized third-party certifier body, were stationed there to inspect by dissecting samples from every batch of harvested fruits prior to treatment. With their limited labor, in peak days of harvest season, the inspection could be a bottleneck throughout the entire packing process from entry to shipment at the packinghouse. What exacerbated the managers' frustrations was that, as explained in Chapter 6 (on the history of post-harvest treatment), the work conditions of inspectors were rigidly determined by the Work Plan so that extra-hour work must be compensated and daily maximum work hours were capped. Accordingly, it was a real challenge for the managers to adjust processing schedules to the availability of the inspectors. In addition, accommodation of the inspectors, including meals and transportation from and to hotel and lunch, had to be arranged and paid for by the packers. Given the demanding task of handling their inspectors, a manager of a packinghouse was explicit in expressing his frustration with them by calling the inspector "*molesta* (annoying)."

On the other hand, the inspectors also had a say. The USDA inspector emphasized that although some packers would think of him, his job, and the authority associated with it as *molesta*, he was just doing his job to meet the conditions for export. He went on to say to me that if I had spent enough time in Mexico, I would perceive the mentality of some people who would not understand why such rulings were needed; and even worse, particularly in northwestern states such as Sinaloa among many mango producing states in Mexico, people were more antagonistic to the inspector. Another senior USDA officer who had worked as an inspector had even a life-threatening experience with a packinghouse manager who demanded the inspector overlook a minor error in HWT and issue a certificate. Raging at the inspector's refusal, the manager pulled out a handgun and threatened to shoot him unless he would agree to give the certificate. The inspector managed to calm the manager down somehow—the inspector said to me that the manager raged for 20 minutes or so—and convinced him to withdraw the gun and to obey the rule. Although such an escalated confrontation might be rare, minor frictions happen "*siempre, siempre, siempre* (always, always, always)" in a packinghouse.

Indeed, during the tour of the packinghouse, smoldering tensions between the packer's employees and the inspectors were quite obvious. Almost no one among the packer's employees would greet or even give a glance to the inspector walking with me. The two inspectors accorded in that they perceived that almost no one in the packinghouse liked them, as presented in the previous chapter. Instead, one of the inspectors was loudly talking to me about the problems and frictions he had with that packer even in the presence of its employees as if he wanted to vent his frustrations. Such a perception of antagonism marked a stark contrast with when I was walking alone and received friendly greetings from many staff members.

Some confrontations or tensions between the packer and inspectors became sustained and explicit conflicts, and mentally disturbed those involved in the confrontation. A manager of the packinghouse revealed to me that while many inspectors were willing to be flexible to respond to her requests, some were not collaborative; when the manager repeatedly asked one such unsympathetic inspector for collaboration, he became openly antagonistic and even abusive. After she reported his abuses to his supervisor, his antagonism escalated rather than being restrained. He would even threaten to cancel the certified eligibility of the packer for the export program. She heard that he was eventually fired because he had acted in abusive manners in other packinghouses. However, in such a stressful occasion as when an inspector was not collaborative, disturbed by the abusive inspector, she would give a yell ("*Grito*") in her workplace.

Finally, what became clear in this context was that this manager faced "power," which could be defined, following Miyadai (1989), as an experience by an obeyer of pressure to select specific options. Despite unreasonable requests and malicious attitudes of some inspectors, the manager obeyed their orders, "*como lo que digan* (as what they say)," in order to obtain certificates from them, because she felt *as if* she had no other choice to do so and because she thought she would get in trouble if she got behind schedule. The power in this context neither should be deemed as an attribute of the inspectors nor even as merely exercised by the "powerful" U.S. government or any single entity. Rather, it was an experience of the manager situated within complex configurations entailing asymmetrically distributed resources (e.g., the inspector's authority to issue certificate), anticipations (e.g., that harvested fruits were accumulating and perishing), or normative expectations (e.g., that she should not delay processing and shipping), which all together urged her to feel that there was no other choice but to obey the inspectors, despite the fact that she could have acted differently.

9.3 Summary and Discussion

This chapter has illuminated some corollaries of the PS regulation network, such as values, norms, and moral senses as well as order and conflicts. PS regulations, a quintessential example of products of scientific knowledge, were not simply providing apparently value-neutral distinctions between pest/non-pest, but engendering very value-laden corollaries, which provided people with normative guidance and moral-based esteem or disdain as to the entire personality of a human. For example, certain practices (or lack thereof) required for pest control, including disposal of unharvested fruits or appropriate pruning of trees, could lead to value-laden evaluations of things or humans, such as a poorly managed orchard or a good grower. Such value-laden evaluations in accordance with what the regulation commands could serve to normatively guide how a person was to act. Tacit infusion of norms into individuals embodies neoliberal ideology that commands self-disciplining in the context of the governance shift.

Meanwhile, non-compliance to rules could be deemed as a breach of morality, which leads to accusations against the personality of a non-complier. A problematic consequence of such a moral accusation was that by attributing problems to the *whole* personality, it could obscure varying circumstances that might in fact hinder the person from observing the rules. Meanwhile, normative senses emerged not only among those directly engaged in production or export of mangos, but also, as the regulatory network extended its reach, among those who were not involved even in agriculture.

In the meantime, behind the apparent ordering effects of the regulations was disorderliness, including disobedience to and breach of the rules. Conflicting situations could also result in disorderliness, including destruction of relatively "peaceful" communication or disturbance to human mind or even body. Yet, I argued that a scrutiny of the concept of conflict would be needed to avoid the problematic confusion of conflict with disorderliness and to make distinctions between (1) conditions that potentially provoke conflicts, (2) conflict as a coherent chain of acts communicating rejection, and (3) "negative" corollaries provoked by a conflict. My analysis illuminated that the mango packinghouses indeed were rife with potentially conflicting situations because the places were where different interests confront each other competing for dominance, that is, a site of politics. Hence, tensions between the official inspectors and the employees of the packinghouses were quite obvious. In some rarer cases, even more explicit confrontations involving threats with a firearm or with the authority to deprive the packer of the certification took place. Whether implicitly smoldering tensions or explicit confrontations, these acts communicated refusal of claims or demands of the competing parties, and hence were conflicts between them. These conflict situations further provoked disorderliness, including discomfort, breach of peaceful communication, mental disturbance, and so forth.

A critically important finding was that the confrontations and conflicts I witnessed indicated enactment of power, that is, an actor's experience of being forced to select from limited options, situated in asymmetrically distributed resources, anticipations, and normative expectations. I do not deem the asymmetry to be the result of resource distribution or the existent norms and morals, nor is power the determinant cause of actions, but it has certain influences on configurations of options that would be available to every actor. As with ANT and systems theory, I do not treat power as the *cause* of actors' actions (Fuchs 2001; Latour 1986). Power would not be something possessed by a single person or entity (e.g., a state, an organization), but deemed as a consequence of collective movements of actors, as a result of which power is *attributed* to a specific, whether individual or collective, actor (Fuchs 2001; Latour 1986).

In this sense, power is not a concept to *explain* something that happens in society. Accordingly, simply using the term "power" in an analysis would have little significance unless an empirical concern is placed upon what and how options would be made available to an actor as a function of asymmetrical configurations of resources, and of moralities or norms. In the next chapter, therefore, I will examine how "options" might open up, and simultaneously come to bind, growers enrolled in the mango sector. More specifically, while farmers in Sinaloa might be attracted to the mango production for new options, including better commodity prices and new employment opportunities outside of farming, enrolling in the sector regulated by PS regulations could mean constraint by not only the collective morality as demonstrated in this chapter, but also other bindings such as perpetual dependence on packers and fee payment for the Campaign.

To conclude this chapter, I will present a few important themes. First, global PS regulations and their outcome, the globalization of agriculture, were not merely a mechanism of expansion of trade of agricultural products. Rather than simply drawing distinctions between pest/non-pest, thereby enabling trade of plant products, the regulations engender multiple socio-material ordering effects, including values, norm,s and morals as to things, places, or humans. Second, despite such apparent ordering effects, there was also disorderliness at the very local level where the regulation enacts itself. Third, a tacit (hence barely asked) rationale underlying the expanding PS regulations was globalization of agriculture and food production and consumption, which would supposedly benefit those who were involved in the regulations. Nonetheless, as the reach of the regulations extended to non-farming sectors and created disorderliness as well, a question might be asked: what costs, including moral burdens and potential conflicts, vis-à-vis supposed benefits, by the expanding regulations promoting globalization of agriculture should or could be borne and tolerated in society? While the part of the question as to the supposed benefits of the regulations will be scrutinized in the next chapter, I believe that the whole question is to be addressed by everyone with interest in a globalizing world.

Chapter 10

Justifying the PS Regulation:

How will the Eradication Program in Southern Sinaloa Benefit Small-scale Mango Growers?

In this chapter I will address the last research question: *How are the PS regulations in transition in Sinaloa changing economic prospects for mango growers and packers to tap into global markets of mangos?* As presented in the previous chapter, PS regulations extend their disciplining effects, going beyond the mango production sector, to non-farm populations, including urban dwellers or travelers crossing the PS regulatory boundary (e.g. inspection points on domestic highways). Costs and burdens incurred by the extended regulatory network, whether direct economic ones (e.g., the governmental expenditure for the program operation) or more indirect non-economic ones (e.g., moral duties and legal sanctions over acts that threaten the PS status), must be justified by benefits brought by the regulations. For instance, prohibiting transporting fruits without certification may be justified because breaking the regulation can jeopardize the export of mango and other products, which is an important source of revenue for the entire nation. Yet, this does not mean that those who comply with the rules equally benefit from doing so. Rather, some may end up only paying costs.

However, *determining* what are benefits and costs of the regulations, and *who* is benefitting or losing from it, *who* is paying the costs and in what forms, can be a complicated task since such a question could elicit varying answers in a diffusive and moving social network. Determining benefits as such becomes “politics” (in a broad sense), as the concept of material politics (Law and Mol 2008) leading this research informs. Still, despite such complexity, if not impossibility, of determining benefits, my observations will illuminate how claims for justification of compensational benefits are constructed, whether through negotiation and contestations or more tacit and implicit ways, and proliferate in and sustain the PS regulations network. One might imagine that there are discourses that claim benefits, while perhaps concealing burdens and costs. Therefore, in this chapter I intend to illuminate how accounts of supposed beneficiaries and benefits from PS regulations were constructed and justified. This position resonates with the constructivist "second-order observation" (Luhmann 1998),[37] which means "observation of observation" or analysis of how observation is made in specific contexts. This perspective, paying attention to plural contextualization of observations, aims to highlight and compare varying contexts in which specific benefits are constructed rather than determining the beneficiary or the benefits of PS regulations as such. Thus, several pertinent questions arise as to: What were rationales or justifications for PS regulations and related programs? What benefits were the regulations supposed to bring? How likely is it that such benefits would materialize and how might that happen? And, are there going to be unanticipated externalities, such as "hidden" costs or risks?

The following sections will first focus on how accounts of benefits and/or beneficiaries of the PS program, the eradication program, in particular, were made and justified. Two sections that follow will examine prospects of demands for mango, and the status of mango production in Sinaloa, which underlie the rationales for continuing PS regulations, particularly the eradication program to establish a PFA. To examine the

[37] This can be compared with the first-order observation, which means observation that *determines* beneficiaries or benefits.

accounts of prospects of benefits by the PS program, the following section will delineate broader political-economic backdrops surroundings mango growers and packers, especially small-scale farmers (peasants) in Mexico, and particularly in southern Sinaloa, where the pest eradication program is in operation. My analysis will center on the complexity with which the local famers (as the supposed beneficiaries of the PS program) produce mangos under the regulatory controls. Based on the analyses of broader political-economic conditions and local-specific relationships between small-scale mango growers and packers/exporters, the chapter will conclude with an examination of whether and how the prospected benefits of the program can be achieved.

10.1 Variations in Rationales for PS Regulations

An entomologist working in a governmental institute, in response to my question asking who are the beneficiaries of his research on fruit flies, asked me, with a jokingly (or perhaps seriously) sarcastic tone, “Why did you ask [such a question]?” Then, although for him it might be something too obvious to ask, he gave me his answer: “*Agricultores*” (farmers). Farmers would be able to expand their fruit production and tap into more marketing opportunities, including export markets. As such, his accounts were valid. Yet, as suggested earlier, a claim of benefits or beneficiaries of PS regulations or research to improve PS programs should be interpreted as contingent actualization among many other possible, contextually-varying accounts. For instance, accounts by those who are importing fruits can differ from those of exporters. According to a U.S. entomologist, for countries requiring PS treatment on *Tephritidae*, the major significance of PS requirements for importing countries lies in its quarantine purpose. This means that the research intends to prevent the pest from crossing a quarantine border in order to protect growers of crops within in it, rather than to develop control measures in production fields (e.g.. field fumigation, mechanical-cultural practices – see Chapter 4 and 7).

Even if farmers of exporting countries are deemed as beneficiaries, one might expect there to be considerable variations among them. Martin Aluja ([1994] 1993), a renowned Mexican entomologist specializing in *Tephritidae* fruit flies, emphasizes the importance of the research on the biology of fruit flies to help small-scale farmers, especially those in developing countries, be able to market fruits in export markets. And even among small-scale farmers in developing countries, there are variations. Another Mexican researcher working in the same institute as the aforementioned entomologist explained that some groups of guava growers in Mexico cannot expand their market chances due to regulatory obstacles,[38] which might be overcome by research. In fact, according to him, research on *Anastrepha striata* (guava fruit fly), which prefers guava (*Psidium guajava*) as a host, was given less priority, lagging behind the other major *Anastrepha* species, such as *A.ludens* (Mexican fruit fly) and *A. obliqua* (West Indian fly). The comparative lag in research on *A. striata* might be accounted for by the fact that commercial usage of guava, especially fresh consumption in so-called developed countries such as the United States, is very limited. Still, while it is obvious that its consumption in the United States is limited and that research on guava fruit fly is also limited, the relationship between these two facts is not straightforwardly obvious—while the limited research might be attributed to the limited consumption, one could also attribute the limited consumption to the limited import because of the lagging research on

[38] The US banned its import until recently when irradiation was accepted as a viable quarantine treatment in 2008.

A. striata.[39] Earlier students of STS demonstrated how the “social” affects the direction or outcomes of scientific and technical research, by articulating the former (“social”) as a causal-explanatory variable explaining the latter (science). However, their relationship should be deemed as both conditioned *by* and simultaneously condition*ing*, in a reciprocal dialectic fashion, rather than a unilaterally causal mechanism.

Meanwhile, a few informants also pointed out benefits of PS regulations, the Campaign in particular, for consumers of Mexican mangos. An officer of the PS regulatory authority pointed out general benefits that U.S. consumers would enjoy from fresh, better quality, safe Mexican products. Today, concerns of U.S. consumers (or concerns that retailers or buyers claim to relay from consumers) about product quality, food safety, environmental friendliness, and even ethical production methods have been heightened. Mexican farmers and food producers were becoming increasingly conscious of the need to comply with standards and demands of the U.S. buyers, since doing so would constitute and maintain their competitiveness. Thus, CESAVESIN (Phytosanitary Committee of the State of Sinaloa) had held annual “Mega Conventions” on PS issues in agricultural production since 2007, focusing on topics such as food safety and hygiene issues and gathering many alarmed growers and food producers.[40] In a few mango

[39] There could be still other reasons for the limited consumption and research investments. For instance, guava contains many small, hard seeds, which hinder fresh consumption of the fruit. However, my point here is that as a sociological inquiry this study always seeks possibilities of making alternative accounts.

[40] The theme of the 2008 “Mega Convention” I attended in Mazatlán, a famous tourist destination, was concerned specifically about food safety and hygiene issues in agricultural production (but not livestock production). There had been a discovery in the US of salmonella-contamination in salsas whose ingredients allegedly had been produced in Mexico. This incident perhaps caused concerns among food producers and Mexican

packinghouses in Sinaloa I visited, signboards commanding employees to follow hygiene practices, such as washing hands, were conspicuously posted everywhere in the facilities (Figure 10-1). In addition, a manager of one of the packinghouses showed me a contract document concerning GAP, indicating the buyer's concern about broader issues throughout the production and packing processes. On one hand, in such a context where the capacity to conform to standards, whether food safety, plant- and animal-sanitary, or quality certification, directly leads to competitiveness in markets, compliance with the PS regulation *per se* would constitute benefits of adding competitiveness to the entire agriculture and food sector of the country. On the other hand, whether conspicuous or tacit, continuous exigencies or pressures from buyers, retailers and consumers could mean dragging growers and packers to, and keep running on, a "treadmill" of compliance to norms and standards.

governmental officials as to whether and how the U.S. regulations would be altered or tightened.

Figure 10-1 Signboard posted in a mango packinghouse in Sinaloa

There were, of course, benefits specifically pertinent to the particular PS eradication program. Whereas HWT can damage the taste and shelf life of mangos, fruits grown in PFA have better fruit quality. A manager of a packinghouse energetically emphasized better taste of non-HWT mangos, saying that it would be completely different. According to him, although we called them “fresh” mangos, they were no longer fresh because they were “cooked” with hot water. However, this benefit was not well known among U.S. consumers, since the availability of non-HWT Mexican mangos was still limited and there was no way (but the better taste *per se*) to know whether a fruit was hot-water treated unless it was sold with an original box with a USDA stamp (proof of HWT) shipped from a packer. In addition, from my observations of retailers in the United States, there seemed to be no difference in prices or “premium” on Mexican mangos grown in the PFA. This means that consumers incur no specific “cost” to establish PFAs in Mexico. The truth is that the Mexican government (hence, the nation), as well as mango growers and packers, bear the costs for the additional, if any, benefits for consumers by the eradication program. These circumstances would make the consumer benefit less visible to the beneficiaries themselves.

While there were multiple accounts of benefits of PS regulations and related programs and research, the most relevant was the eradication campaign against *Tephritidae* (fruit fly) pests in southern Sinaloa, because it was expected to attract mango growers to the area, including underprivileged peasants. In this specific context, the most significant rationale for PS regulations was to establish the PFA, which would "liberate" mango growers who were reliant on packers and intermediaries who had access to the mandatory HWT and/or commercialization channels. Once the entire state of Sinaloa becomes free of the pest, HWT as the requirement for export will no longer be needed. Then, any grower can export mangos to the United States and Japan, two major importers that require PS treatment, without relying on packers or intermediary buyers (or brokers) for marketing. Moreover, if non-HWT fruits are recognized for better quality, "premium" prices may become another reward for producers (although such has not happened so far).

This benefit would be particularly pertinent to those small-scale, peasant growers of *ejidos* (pronounced "e-Hii-do"), who lack equipment for the mandatory HWT and thus are in a vulnerable position vis-à-vis intermediaries or packers with access to HWT. To understand situations surrounding *ejidos*, Mexican peasants, a brief historical outline will be helpful. In Mexico, there are two different systems of entitlement for use of land, including private ownership and the "*ejido*". The latter, which was established in the 1917 Constitution in the era of the Mexican Revolution, means the communal right for farmland use (and a group of peasants entitled to the right). In the land reform carried out throughout the Revolution, the federal government granted lands (confiscated from large landlords) to groups of landless peasants. The granted lands themselves did not belong to the group or an individual peasant. Each peasant member was granted only the right to use a portion of the granted land. A group of peasants and their entitled lands are together called an *ejido* and a member of an *ejido* is "*ejidatario*" ("e-hi-da-Ta-ri-o-s") or "*ejidataria*" (for woman). Since the historical root of the *ejido* can be traced back to the poor landless peasantry, *ejidos* in general have tended to be underprivileged, lacking financial and/or technical capitals, compared to private landowning farmers. In this study, *ejido* farmers (*ejidatarios*) are called "peasants" to indicate their underprivileged status. Although there had been strict regulations over concession or trade of the land use entitlement of ejidos, an amendment to the Constitution in 1992 under neoliberal reforms of the farming sectors drastically relaxed the restrictions, allowing non-peasant farmers access to *ejidos*' lands. While the *ejido* system constitutes the "revolutionary" national identity of Mexico, its nature has been drastically altered in recent years when neoliberal political discourses are dominant.

Given the relative weakness of the *ejido* sector, a few informants told me that "brokers" or intermediaries (often called "coyotes," perhaps reflecting their negative image) from other regions treated local peasant growers in an abusive manner. However, most peasants had to rely on packers or intermediaries to sell fruits. "Liberating" the region from the pest could mean eliminating the cause of the reliance, thus also "liberating" resource-poor, small-scale growers from the position subordinate to coyote buyers or local "elite" producers/packers. Upon completion of a PFA in southern Sinaloa, many peasant mango farmers would be able to tap into the larger export market without being bothered with others. So, while farmers, consumers, and peasants could be all potential beneficiaries, in what follows I must investigate further in order to examine validities of the “beneficiary discourses,” as well as the likelihood that the potential benefits of PS regulations would really materialize.

10.2 Prospect of Mexican Mango Export Markets

One of the critically important premises to materialize the potential benefits, especially for mango growers, is the steady growth of export markets of Mexican mangos. What underlies the rationale for PS regulations, whether discussed explicitly or not, is that there are optimistic prospects of the growing export market of mangos. Without a persuasive projection of growth in major markets for mangos, a good prospect of one of the most important potential benefits of PS regulations (i.e., better chances for Sinaloan mangos) would not be persuasive. My interview with a representative of EMEX, an organization of packers and exporters of mangos in Mexico, while validating this premise, illuminated shifting and significant trends in the major markets for Mexican mangos for export.

In recent years Mexico has been the largest supplier in the U.S. mango market. After hurricanes, frosts, and urbanization caused Florida-based mango production to fade away, Mexico has become the largest supplier in the U.S. mango market and its supply has been expanding. The EMEX representative added that there would be a projected change in the United States, not simply in the export quantity, but also in the pattern of consumption in the near future. Currently, according to him, particular ethnic groups, such as Hispanics and Asians (as opposed to European- and African-Americans), are major mango consumers in the United States. For many U.S. people, the mango is still an "exotic" fruit compared to commonly consumed fruits such as apples, bananas, or oranges. The representative hopes that as the supply of mangos from Mexico and the rest of the world rises and its price decreases, the fruit will be less exotic and become closer to those common commodities so that more people in the United States would be attracted to this fruit. To push this trend further, mango packers and exporters in exporting countries and traders in the United States are making collective efforts to provide information on consumption of mangos, including recipes and nutritional values, to raise publicity of the fruit in the United States.

In addition, Japan, which is the third largest importer of Mexican mangos following the United States and Canada, is also a promising market. Although the quantity of Mexican mangos shipped to Japan (less than two percent) is still minuscule compared to that for the United States, the market growth during the past decades has been much higher than the other major importing countries (Table 10-1). The average unit value of Mexican mangos shipped to Japan (1.74 $US per kg) has been superior to those for the other major importers, such as the United States. Thus, compared to the export to the United States, where the total export values have not grown despite the growth in volume, Japan has become a "premium" market for Mexican mangos.

Table 10-1 Exports of Mexican mangos to major destination countries (1988-2008)

Volume (metric ton)				Change (%; 1988 data = 100)	
Country\Year	1988	1998	2008	1988-2008	1998-2008
USA	13,530	180,133	194,914	1,441	108
Canada	327	18,434	24,051	7,355	130
Japan	60	1,239	4,776	7,960	385
Netherlands	222	3,286	1,836	827	56
France	171	1,170	209	122	18
Germany	0	612	61	NA	10

Export Value ($US1000)				Change (%; 1988 data = 100)	
Country\Year	1988	1998	2008	1988-2008	1998-2008
USA	3,825	122,450	79,216	2,071	65
Canada	89	12,026	18,004	20,229	150
Japan	116	1,906	12,052	10,390	632
Netherlands	85	2,233	1,059	1,246	47
France	59	892	420	712	47
Germany	0	358	65	NA	18

Unit Value ($US/kg)				Change (%; 1988 data = 100)	
Country\Year	1988	1998	2008	1988-2008	1998-2008
USA	0.28	0.68	0.41	144	60
Canada	0.27	0.65	0.75	275	115
Japan	1.93	1.54	2.52	131	164
Netherlands	0.38	0.68	0.58	151	85
France	0.35	0.76	2.01	582	264
Germany	0	0.58	1.07	NA	182

(Source: FAOSTATS http://faostat.fao.org/)

The EMEX representative's account indicated that at least among the mango packers/exporters, there existed an optimistic prospect of opportunities for Mexican mangos to grow in the major markets, the United States, Japan, and Canada. Yet, access to the two promising markets both in the United States and Japan requires clearance of PS regulations on *Tephritidae* fruit flies. Maintaining and promoting the appropriate operation of the required control measures, including HWT and on-site pest monitoring, could thus be justified. Specifically, PFA as an alternative to HWT, which not only is costly but also damages fruit quality, would be a legitimate measure to make Mexican mangos a more competitive and attractive commodity in the markets of the two countries mentioned above.

10.3 Rising Mango Production

10.3.1 Growers opting for mangos in southern Sinaloa

The prospect of a growing mango market represents an incentive for peasant growers to switch from other conventional crops to mangos. My informants told me that in southern Sinaloa, Escuinapa, and El Rosario, the two largest mango-producing municipalities of the state in particular, farmers had been opting for growing mango as one of the principal crops, instead of conventional products such as wheat, frijol (bean), or livestock. In the interviews the informants reasoned that farmers, including peasants, came to be attracted to mango principally because of its potential profitability, less labor, and lower costs for production. In short, growing mangos appeared to give a better economic prospect. A couple of farmers I interviewed told me that in recent years they had switched from frijol, corn, and livestock production to mango because other crops had become less profitable; whereas some other crops, especially vegetables for export markets such as chili and green peppers were also promising, they would require more intensive labor and capital to produce. Also, as I will discuss later in this chapter, an important backdrop of their accounts concerns changes by Mexico's political-economic reform towards liberalization, deregulation, and privatization. The Mexican government ceased some of its supports to the peasants, including the procurement of staple crops such as corn and frijol, in order to prompt the agricultural sector to adjust to an open market economy. This has lessened the viability of the conventional crops as stable income sources for resource-poor peasants who could not afford to make investments to compete with cheaper products flooding the open market. Earlier literature in the sociology of agriculture inspired by ANT (e.g., Busch and Juska 1997) could provide an explanation of Sinaloan peasants' adoption of mango as "enrollment" into a network of a commodity chain. Following Busch and Juska's account (1997), one may reason that, when provided varying options to enter networks, an actor would calculate benefits, negotiate with other actors, and enroll into a new network consisting of diverse actors including humans and non-humans.

However, whether their opting for mango was based on a careful, "rational" calculation of profit/cost (or labor) would need a cautious examination.[41] For, in general, as argued in works following "actor-oriented approach" (AOA) (Long 2001; Long and Long 1992), motivations underlying peasants' responses to macro socio-economic changes vary. Rural people at the local level, faced with global economic changes, enact

[41] Certainly, I could argue that the peasants' opting for mango based on "non-economic" calculation was in line with other dimensions of "rationality," following sociology's tradition, such as substantial rationality (Max Weber), as examined with US family farms in the US by Mooney (1985).

diverse responses as livelihood strategies, including opportunities out of agri-food commodity chains. For instance, mangos seemed not only profitable but also appeared to demand less labor, which would allow them to use their time for other economic activities, including performing contract farm labor and temporary work in fisheries (shrimp, in particular, has been one successful income source as an alternative to agriculture after 1990s when the state economy was stagnant (López Cervantes 2007)). Their response is undergirded with varying cultural and value resources (or cultural capital, following Bourdieu (Bourdieu and Wacquant 1992) that allow for different and contingent interpretations of situations. Also certain sets of existing networks (as social capital following Bourdieu (Bourdieu and Wacquant 1992)), including global and local commodity chains and other institutions, such as political-administrative or legal frameworks and local community relationships, allow them to (re)configure multiple livelihood strategies, simultaneously transforming the existing networks and value or cultural bases (de Haan and Long 1997; Echánove and Steffen 2005; Long 2001; Long and Long 1992; van der Ploeg 1990; Zendejas and Vries 1995).

Thus, for my study, it is important not only to focus on how an actor successfully is enrolled and actualized in a network of the specific commodity network (and how the network may eventually fail—see narrative of how a network of scallop industry developed and failed (Callon 1986)), but also to pay attention to what is not actualized, not negotiated, but excluded and concealed from negotiations, to enroll in the network. While a "rational" economic calculation (which may lead to enrollment in the network) might be a plausible explanation for the shift of the crop, more "irrational" and contingent factors opened up the possibility for peasants to jump on the bandwagon of mango-growing. According to a peasant in southern Sinaloa, for instance, farmers started growing mangos because they had heard from friends or relatives about success and prosperous potential of the new fruit. However, growers "jumping on the mango bandwagon" may face a situation where their capacities are limited to negotiate for better positioning within the mango commodity network, and eventually expose other uncertainties or risks, if not at risk of failure. Accordingly, the following analysis will examine the relationship between growers with packers, mediated through PS regulations, intertwining with other broader, complex political-economic backdrops such as Mexico's neoliberal (and post-neoliberal "re-regulation" (Snyder 2001)) reform, as well as farmers' livelihood strategies under the transition. In doing so, I will discuss that PS regulations, which have been increasingly restrictive and comprehensive, seem to have much to do with the sustained dependency relationship, which both allows and constrains the actors' "entry" to the network of the mango market. To that end, first, I will delineate the situation of southern Sinaloa where peasantry mango growers are concentrated.

Southern Sinaloa, a "low prevalence area" where the eradication program was in operation, is where the state's mango production was concentrated, particularly in Escuinapa and El Rosario, the two largest mango-producing municipalities in the state (Figure 10-2). Mango groves and growers registered for export to the United States were also concentrated in the area, with more than 2600 groves and 2100 growers, compared to less than 200 groves and growers in the northern area (Figure 10-3). However, their productivity was less remarkable compared to areas already free of fruit flies. With the greater number of growers and groves, average sizes of groves were smaller than almost all the other mango producing municipalities (Figure 10-4). Average yields in the south tended to be lower than the north (Figure 10-5). As shown in Figure 10-6, more mango groves in the southern region lacked irrigation. Availability of irrigation could be not only an important factor for determining yield levels but also stable production of quality fruits, which would directly affect their prices (Figure 10-6). The low productivity in southern Sinaloa could be attributed to small-scale growers' lack of technical and/or financial capital for production. Their dearth of production capital will be discussed in detail in what follows.

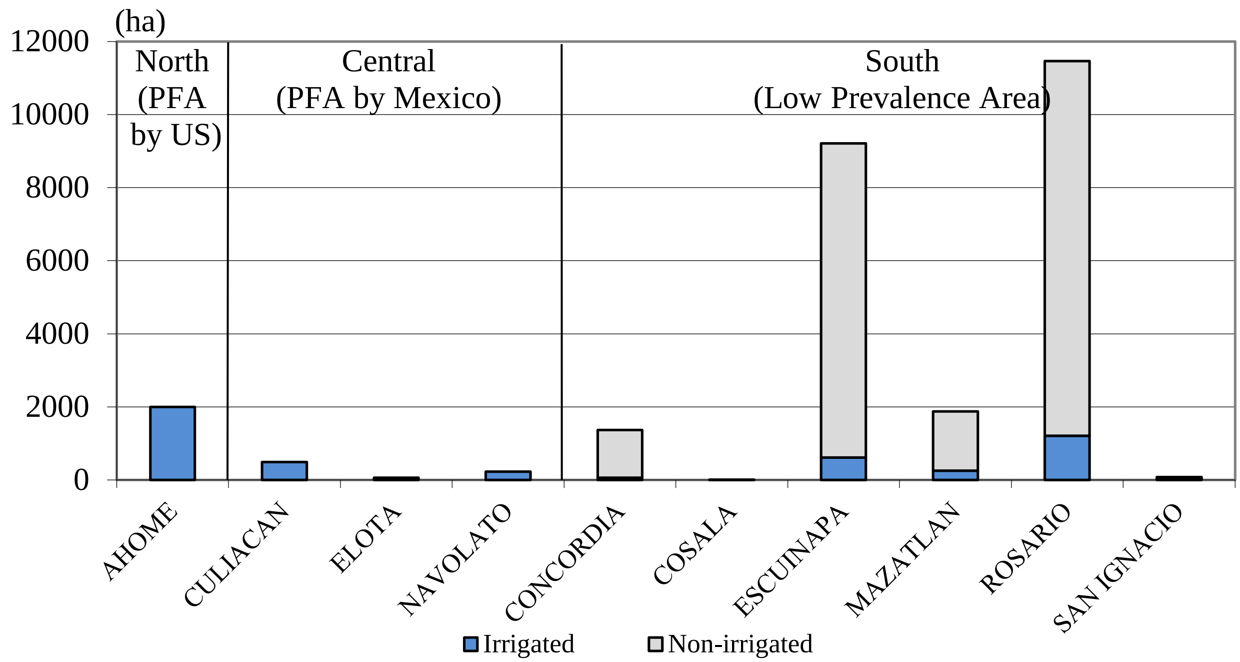

Figure 10-2 Areas of mango orchards in municipalities of Sinaloa, Mexico, by availability of irrigation (2007)
Source: INEGI

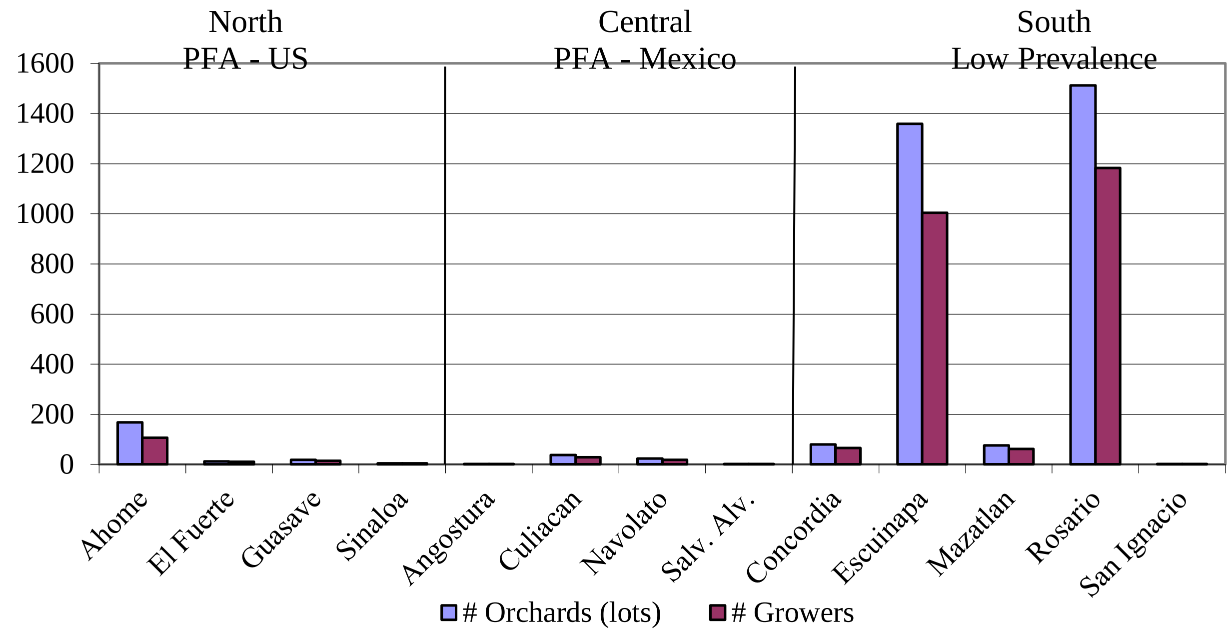

Figure 10-3 Number of mango groves and growers in municipalities of Sinaloa (2007)
Source: INEGI

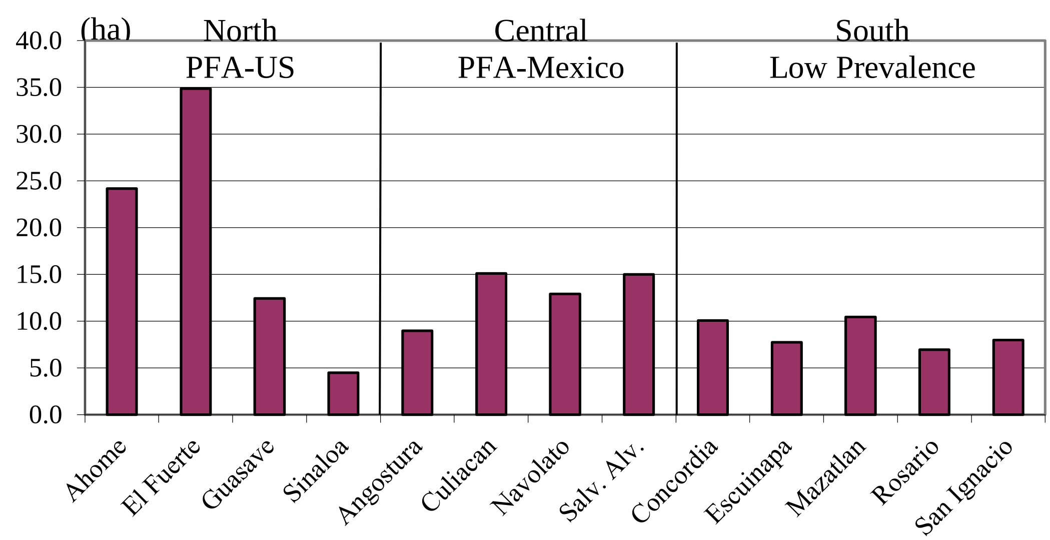

Figure 10-4 Average sizes of mango orchards registered for export to the United States (per grower) in municipalities of Sinaloa
Source: USDA

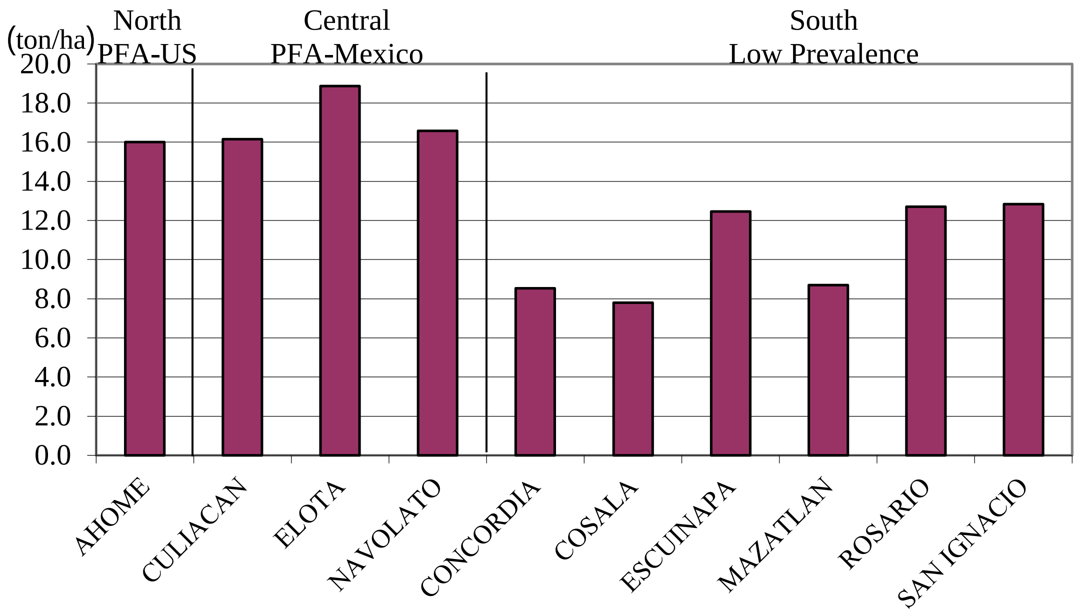

Figure 10-5 Average yields of mangos produced in municipalities of Sinaloa (2007)
Source: INEGI

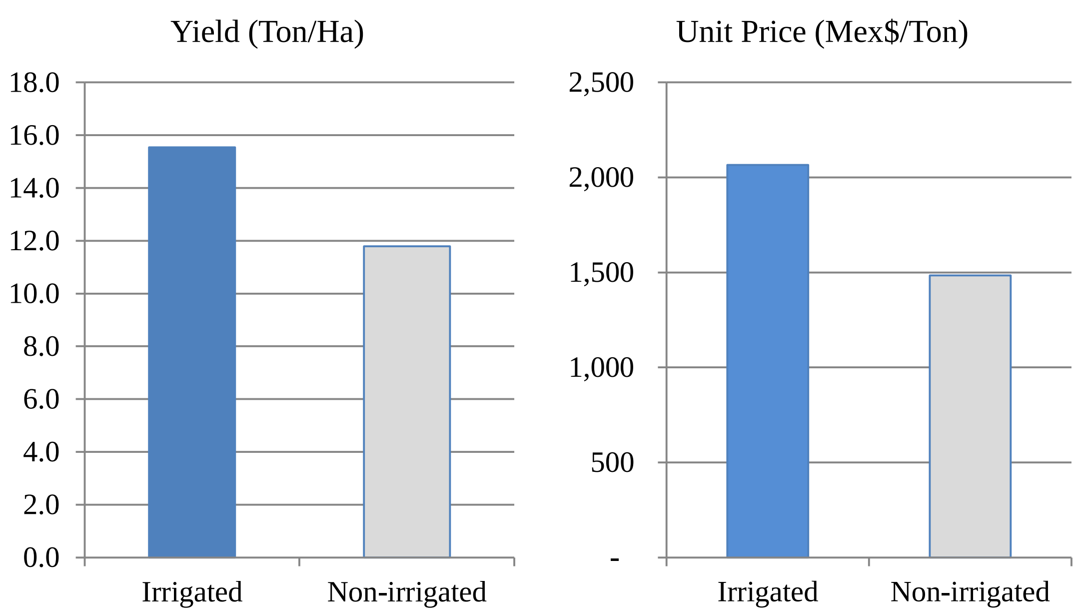

Figure 10-6 Average yields and unit prices of mangos produced in Sinaloa by availability of irrigation (2007)
Source: INEGI

10.3.2 Small-scale mango growers lack production capital

Small-scale growers in southern Sinaloa were also prone to being excluded from access to resources for production and/or commercialization. For instance, commercial suppliers of materials, such as fertilizer and pesticides, were not willing to sell their products to small-scale operators. During the fieldwork, I attended a business meeting of an *ejido*. Salespersons of a few companies of farm material supplies were also invited to introduce products available for the peasants. A few extension technicians, including one with whom I had an appointment, were also invited to the meeting to give a workshop on fruit crop production, including mango production. What drew my attention was that the salespersons were emphasizing that they were there for business (*comercio* in Spanish) and not to provide free service to the farmers, although they would be glad to help through *comercio*. In a later interview I conducted with the technician who gave a lecture in the *ejido*'s meeting, I asked about the salespersons' comments. The technician explained that many commercial suppliers would be unwilling to make transactions with small-scale operators needing only small batches, especially when purchasing with unreliable credit. Indeed, Marsh and Runsten (1998) identified such high transaction costs as one of the challenges faced by Mexican peasant fruit and vegetable growers.

Also, I learned that the meeting I attended was something unusual for the *ejido*. In another interview with representatives of the *ejido*, they revealed that the meeting involving the technicians and the salesperson was a really novel experience for them. The *ejido*, as a group facing limited technical and financial support, had never had such an opportunity to learn technical suggestions about different fruit crops, soil and fertilization management, and pest control. Indeed, at the end of the meeting, I witnessed a farmer express his appreciation to the salespersons and the technicians for their talks. With the workshop being the first of the kind for this peasant, his unusually polite expression of his gratitude demonstrated by his standing up among the audience mirrored the *ejido*'s dearth of access to technical and production capital.

An anecdote of a packing facility of this *ejido* also epitomized their financial and technical situations. According to the leaders, this *ejido*, using this facility, used to pack and ship their mango fruits by themselves to both the domestic and export markets until the mid-1980s when the use of EDB was banned by the U.S. EPA for its carcinogenic potential (see Chapter 6). However, the *ejidatarios* could not finalize installment of HWT, a mandatory alternative to the banned EDB fumigation to meet PS requirements for export.[42] Despite their attempt to equip themselves with HWT device, they had no option but giving up exporting fruits by their own means (Figure 10-8). More than twenty years after ceasing their packing operation, the anticipated eradication of the fruit fly pests opened up the opportunity for the *ejidatarios* to resume commercializing mangos on their own. When I visited the office, the *ejido* leaders were preparing a proposal to obtain financial support to resume operation of the facility.[43] In the interview, however,

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[42] I should note, however, that there were competing or conflicting narratives about this packinghouse. Another peasant in the same region claimed that that particular packing facility had never shipped mangos to the US, but only to Canada, which has not required PS regulations against fruit flies. Still, the relevance to my research of the narratives of this packinghouse lies not in whether the packinghouse was really shipping fruit for export. Regardless of whether or not members of this *ejido* exported mangos to the US, it was the case that they were currently struggling with securing capital to tap into opportunities of the apparently prosperous mango exports.

[43] Unfortunately, I had no opportunity to address a question to specify financial sources they were looking for.

notwithstanding the positive prospect of mango production, they emphasized how hard it was for resource-poor *ejidos*, compared to private large-scale farmers, to obtain financial and technical support for their commercialization.

Figure 10-7 Inside of the abandoned packing facility
Containers ("bathtubs") were reminiscent of the uncompleted construction of HWT equipment.
(Photo by author)

The serious paucity of production resources for Mexican peasants growing fruits has been documented in many works (e.g., De Janvry, Gordillo, and Sadoulet 1997; Marsh and Runsten 1998). Fruit and vegetable production was encouraged as alternative income sources for peasants especially after the late 1980s and 1990s when the Mexican government geared their economic policies towards liberalization. Mexican policymakers reasoned that conventional grain production such as corn and frijol would no longer be a viable choice for peasants, as the relatively generous support at the time, which the government offered through parastatal companies, such as price support and credits to the conventional crops, were supposed to cease (for detailed accounts of governmental support since t1970, see (Fox 1993); for the process of decline of the governmental supports and consequences for peasants, (De Janvry, Gordillo, and Sadoulet 1997; Echánove and Steffen 2005; Kurtz 2004; Myhre 1998)). However, while giving the push to adopt fruits or vegetables, the government provided peasants with very limited, if any, support for transition, since the existing service channels were demolished. The parastatal institutions, which not only provided financial support but also technical assistance and material supplies (e.g., fertilizers or other agro-chemicals, or in some cases, seedlings and seeds), were dissolved or liquidated in the neoliberal policy reform following the late 1980s. Marsh and Runsten (1998) noted major constraints or challenges that peasant fruit and vegetable growers would face, including lack of marketing channels and skills, undercapitalization (e.g., lack of credit to obtain production supplies, of transportation measures), poor technical and extension supports, and higher transaction costs due to small batches (an important factor for financial institutions, material suppliers, and buyers doing business with peasant products and creditors). These factors correspond squarely to what I witnessed with the *ejido* struggling to tap into the apparently promising market opportunity for Sinaloan mango producers.

Particularly pertinent to what I witnessed in the *ejido*'s meeting were the availability and changing scheme for the provision of technical support and extension service. To adopt more "value-added," market-oriented commodities, especially for export markets, initial technical support would be crucial for small-scale farmers who lack previous experience since those new crops definitely would need substantial technical investments to meet more stringent quality demands. However, agricultural research and development programs by governmental institutions, which could have provided significant assistance to the peasant sector, had suffered severe budgetary and human-resource cutbacks. Throughout the reform toward deregulation and liberalization, the public extension service was discontinued and research programs on some crops by INIFAP (National Institute of Forest, Agriculture and Livestock Research), the flagship research institute of the Ministry of Agriculture (SAGARPA), had substantially decreased (Echánove and Steffen 2005; Marsh and Runsten 1998). When I visited one of INIFAP's research centers located in suburb Culiacán, the state capital, its falloff compared to a few decades ago was clearly reflected in the facility, the almost-abandoned library in particular. Although in fact the library stored precious research documents from all over the world, it seemed the room had been converted into a junk shed—on its floor dead cockroaches were scattered and even a mummified snake body was left. Also, INIFAP-Culiacán was once active in selection of germ-plasm stocks of mango in an experimental orchard in Aguaruto, suburb of Culiacán, which once had been the most important genetic resource for the Mexican mango industry. However, the experimental lot was transferred to another organization. When I visited there, it seemed to be under fairly poor conditions perhaps due to limited budgets and human resources.

Instead, what emerged as significant players in agricultural research, development, and extension, at least in Sinaloa, were non-governmental organizations, such as *Fundación Produce*, an affiliate organization of CAADES, the umbrella organization at the state level under which local-level organizations of private-landowning farmers were associated. Thus, CAADES itself was not affiliated with the *ejido* sector. However, *Fundación Produce* was engaged in research, development, and extension to provide support to both private farmers and peasants in the state. Indeed, the technicians who gave the lecture in the aforementioned *ejido*'s meeting belonged to *Fundación Produce*. Its technicians were obliged to visit at least one farmer per month from both the private farmer and *ejido* sectors. Though the care did not seem sufficient, *Fundación Produce* was the organization now responsible for the aforementioned INIFAP's experimental lot of mango cultivars and conducted research on sustainable mango production practices through contract with a university researcher. If the political reform of Mexico after the 1990s pushing privatization was meant to allow for active and effective engagement of non-governmental private sectors without being bound with rigid, bureaucratic, organizational, institutional, or sectorial boundaries, and if I was to look for a sign of expected outcomes of the reform, then the case of *Fundación Produce* might be one example. In addition, the interviewed technician pointed out that, in recent years, financial and technical support to peasants by the government was being improved despite many claims otherwise. His opinion was that although it was the case that support was not sufficient or effective yet, perhaps many peasants were still unaware of such assistance resources available for them. Still, what mattered to my research centered on perceptions of financial and technical conditions surrounding peasants, including the changing PS regulations.

10.3.3 Cultural factors or (purported) peasant "mentality"?

The analysis by Marsh and Runsten (1998) also pointed out that there were cultural factors affecting the willingness and ability of peasants to switch to fruit or vegetable production in the Mexican liberalization reform in the 1980s to 1990s.

Educational levels of growers and the historical paternalism and anti-peasant biases were included in such cultural factors. In a similar vein, my informants explained about the propensities or characteristics of mango growers in southern Sinaloa. According to their accounts, as mentioned earlier, compared to the northern municipalities in the state, the number of growers in the southern Sinaloan region was large. Among the mango growers, especially those peasants predominating in southern Sinaloa, it would be difficult, if not impossible, to achieve consensus. This limits their collective negotiation ability vis-à-vis local packers and "coyotes" (intermediaries or brokers) from outside of the area.

Also, the extension agent I interviewed pointed out that peasants in the region were prone to be risk-averse. However, he did not intend to disdain such "mentality" of the peasants with those with whom he had worked. Rather, being from a southern state of Mexico where he had grown up with more underprivileged indigenous peasants, he had sympathy with the purported disposition to avoid risks of southern Sinaloan peasants. Such an observation on peasants' disposition also resonated with a remark by an interviewed Mexican social scientist who had conducted research on peasants growing non-traditional crops in the country. For many small-scale peasants, growing fruit commodities, such as mango and avocado, would serve as "insurance." Her commentary went on to explain that, although production of export-oriented fruit commodities would give even peasants a promising opportunity, institutionalized norms, including those on quality and sanitary and PS regulations, had become increasingly burdensome for them to conform to if they were to embark on the export or even domestic markets. When lacking technical and financial resources to meet the regulations or requirements, prospects for small-scale growers to benefit from products whose standards were stringent would not be comparable to those who could count on technical and political-economic resources.

Past research literature indeed has pointed out that in Mexico, while local elite producers successfully collectively mobilized their political resources for negotiations involving the national government to make regulations on fruit commodities such as avocados and mangos more amenable to them, the underprivileged peasantry was not enjoying the same benefits (Echánove 2005; Echánove and Steffen 2005; Stanford 2002). The fruit production as “insurance” then meant that most unprivileged peasantry would perceive it as a supplemental income source, which would ensure them a certain level of income from the prosperous export market, as well as their access (entitlement) to the land. These benefits were made possible by relying on stronger intermediaries, although room for negotiation for peasants with buyers would be limited.

In the meantime, the growers in northern Sinaloa starkly contrasted in many aspects with many southern counterparts. I met a few growers in Ahome, the major mango producing municipality in the PFA, who owned groves and packinghouses. Being much fewer in number, the growers have achieved consensus with relative ease. They collaborate well with each other through providing or exchanging advice in technical aspects or marketing. The northern mango growers, as the aforementioned extension technician said, were more entrepreneurial (*empresarial* in Spanish), eager to explore market chances, and blessed with technical and financial capital. For instance, I visited a recently established, very-large-scale (500 ha or 2000 acres) mango plantation in Ahome, which illuminated the “entrepreneurial” characteristics of growers in the region. The land itself did not belong to a farmer in a strict sense. Having heard about the good prospect of mango, the landowner with little previous experience in farming, asked a technical advisor to make the land a state-of-the-art mango plantation. The advisor, who grew and brokered mangos by himself, and worked as a consultant for other mango growers (and was one of my most important informants), adopted new techniques, including sustainable practices using composts, micro nutrients, and tube-drip irrigation. Throughout the field, even birdhouses were installed for raptors that hunt rats so that their damage to the plants could be reduced without ratsbane. Of course, the entrepreneurial propensity and well-equipped infrastructure of the northern growers never meant that they would be immune to risks inherent to agriculture. Plantations of at least two of the interviewed mango growers in Ahome were devastated by a hurricane that hit the region during my fieldwork. I indeed witnessed their many mango trees torn down and completely inundated. There are always uncertainties and risks in agricultural production. Then, whether a farmer has capabilities to deal with risks, including the ability to obtain needed technical and financial resources, becomes a critical issue.

Certainly, risk-taking entrepreneurial growers were also found in southern Sinaloa. The first commercial production of mangos started by a few risk-taking growers in El Rosario and Escuinapa, who introduced a few new commercial varieties, and to export the fruit to the United States, overcame the PS norms by devising disinfection methods using equipment for disinfection of citrus. A large-scale grower (who was a relative of one of the first mango growers in Sinaloa) had recently begun, perhaps first in the region, certified organic production of mangos. However, in the two major mango-producing southern municipalities, growers who would make such active investments were comparatively few given the dominance of small-scale holdings.

In addition, even for such “entrepreneurial” mango growers and packers, commercialization of mangos, especially for the export market, was a demanding task. An informant in northern Sinaloa told me that one of his colleague mango farmers went through a significant financial loss when his fruits shipped to the United States were returned by a buyer because the products allegedly had not met quality standards. As far as the marketing to retailers in the major mango markets such as the United States and Japan were in the hands of importing traders, room for negotiation of commodities’ prices for packers/exporters, let alone growers, would be limited. A manager of a large-scale mango grower/packer explained that the now deceased owner of the packinghouse, being unhappy with the little room for price negotiations with U.S. importers, established a subsidiary of his own in the United States to market mangos from his packinghouse to U.S. retailers. However, notwithstanding this relative success, not all the growers and packers could afford to take similar risks. It appeared to be quite a hassle for mango packers and growers to develop and maintain marketing channels to export markets. In addition, whether governmental or (semi-)private, standards on fruit quality or GAP, along with PS and other sanitary requirements, would add more pressures on the packers or traders of the commodity to spend more costs for compliance.

Thus, with few exceptions, including the *ejido* struggling to resume packing operations, most small-scale mango-growers were unlikely to opt to embark on commercialization on their own, whether because of the insufficient technical and financial support or their risk-averse “mentality.” And, for purportedly “risk-averse” peasants in southern Sinaloa, mango production virtually necessitated reliance on packers for marketing their fruits. Indeed, critics have reported that marketing is the most critical factor for growers of non-traditional crops and what many peasants were decisively short of (Marsh and Runsten 1998, Echánove and Steffen 2005). Mexican peasants who adopted fruits or vegetables as alternatives to conventional grains would be far less proficient in developing commercial channels than private landowning farmers.

10.4 Political-economic Backdrops Surrounding Mexican Peasants

The above observations of circumstances surrounding, and propensities of, small-scale mango growers in southern Sinaloa could be accounted for as consequences of past Mexican rural policies that provided generous support to the peasantry, which has been the revolutionary identity of the nation. From the 1970s through the early 1980s, the Mexican government under virtual autocracy of *Partido Revolucionario Institucional* (PRI; Institutional Revolutionary Party) developed and reinforced strong patriarchal, corporatist institutional connections with the poor, including the peasantry sector, in order to sustain their monopoly of political domination. This was made possible, as alluded to earlier, through state-controlled, "parastatal" companies that monopolized distribution of resources, access, and subsidies to the poor, who in turn participated in political campaigns sponsored by PRI (Holzner 2010; Kurtz 2004). In this patriarchal, corporatist, political structure, *Confederación Nacional Campesina* (CNC, National Peasant Confederation), a corporatist organization of PRI, served to mediate the relationship between political leaders and peasants by exchanging resources from the former to the latter in exchange for voting support. The period of the 1970s and the early 1980s witnessed the government, through these organizational channels, expand support to *ejidos*, including subsidies for supplies for production (e.g., fertilizers, seeds), finance (credits and insurance, price supports including purchases of peasants' products at guaranteed prices), information (extension and technical support), and distribution (marketing, transportation, and storage) (Fox 1993; Kurtz 2004). Among different parastatal entities, CONASUPO (National Company of Popular Subsistence) and *Banco de Desarrollo Rural* (Banrural, Rural Development Bank) played key roles in these services to ejidos. The former, CONASUPO in particular, did this by securing marketing channels for *ejidatarios* in order to protect the peasantry from private distributors who would take advantage of the weaker marketing ability of peasants by charging excessive transportation or transaction fees.[44] However, the Mexican government steered economic policies towards withdrawal of governmental services, slashing the variety of support to *ejidos*, privatizing parastatal companies, including CONASUPO (and some former employees of CONASUPO were hired by CESAVESIN, as explained in Chapter 8).

While the broad institutional support somewhat successfully sustained the peasant sector, which would not be competitive in the looming market-oriented globalization of agriculture, they also might hinder peasants from developing capacities and skills for marketing on their own. Peasants' dearth of marketing capacities could have become more problematic, since these cutbacks were accompanied with market liberalization, the ratification of NAFTA being a prominent example. Then, resource-poor peasants were left in a desperate situation where their products were exposed to sheer market competition without the protection shield formerly provided by the government. Although the government had programs to encourage the poorer producers to adopt non-traditional crops, they were by no means sufficient or effective. Whereas medium-scale

[44] CONASUPO also had control over staple food import by imposing import licenses.

private farmers, who were expected to be principal players in the modernization of Mexican agriculture, maintained access to subsidized credits from different financial institutions, peasants were left only with limited finances by Banrural or some poverty alleviation—rather than production enhancement—programs (Kurtz 2004; Myhre 1998). Subsidies of such programs supposedly assisting peasant growers were in reality used to obtain staple foods, rather than production materials (De Janvry, Gordillo, and Sadoulet 1997; Marsh and Runsten 1998). Furthermore, after PRI lost the leading position at the national-level political arena in the 1990s to the 2000s, the situation has worsened. Peasants' access to resources for production and survival, formerly mediated through PRI-CNC connections, has diminished. Although, ironically, this encouraged more active, "democratic," political participation at the local levels, including burgeoning of non-governmental organizations (Holzner 2010), peasants seemed to be locked in severe lack of access to resources.

Another very important policy change happened in 1992 when the government amended the article 27 of the 1917 Mexican Constitution. Strict controls over transfer or sales of *ejidal* lands stipulated by the article were relaxed, allowing non-*ejidal* members to access *ejidal* lands for production. Whereas its intention was to make the *ejido* sector more productive and competitive in the open market economy, critics argue that this change led to dismantling of solidarity or social ties of *ejido* communities (de Haan and Zoomers 2003). Certainly, scholars have noted changes in peasants' farm-centered livelihoods after this reform, showing certain signs of adaptation, with "entrepreneurial" posture, to the open economy (e.g., De Janvry, Gordillo, and Sadoulet 1997). At an early stage of the economic liberalization, the 1992 *ejidal* land reform in particular, De Janvry, Gordillo, and Sadoulet (1997) identified certain patterns of the peasant economy adapting to the change. Though varying across households, *ejidos*, and regions, peasants adopted autumn-winter mono-crop corn production, fruit and vegetable production, cattle raising using common-property lands (all three patterns were characterized as "entrepreneurial"), and migration-subsistence strategy. Stories I heard from peasants in Sinaloa, despite considerable variations, seemed to match these patterns of adaptations to the economic reform that was drastically changing as well as repressing the peasant sector.

In addition, one of my informants, who was a grower, consultant, and broker of mangos, acquired access to *ejidal* lands and started growing mangos. As an expert, he had highly sophisticated knowledge, skills, and resources in mango, from production techniques to marketing channels. If other *ejido* members could learn his techniques or utilize his commercial channels, his presence with an "entrepreneur-mind" would be of great help for the *ejido* to be a modernized, independent, farming enterprise. Still, my field observation caught little signal of substantial success of *ejidos* converting their farming into independent agri-enterprises prospering in export sectors. As Kurtz (2004) notes, one might expect uneven (positive and negative) consequences of *ejidal* land privatization because of varying qualities of lands and other production factors. What my fieldwork captured was the struggle and bewilderment of the peasants striving to find and secure resources that would allow for independent enterprises tapping into export-oriented mango production. Perhaps, the question of whether Mexico's political-economic reforms towards liberalization would foster competitive, entrepreneurial, and independent peasants still remains to be answered. And, as discussed below, PS regulations could provide a part of possible answers to the question of whether the "independence" of peasant mango growers would be achieved.

10.5 Analyzing the Prospective Benefits: Continuing Dependency Relationship

Corollaries of Mexico's neoliberal reforms since the late 1980s, as delineated above, indicate that the analysis of whether and how PS regulations, specifically the eradication program in southern Sinaloa, would benefit peasant mango growers, requires careful attention to the complex intertwining of the political economic backdrop with the specific local relationships between relevant actors, such as growers, packers/exporters, intermediaries/brokers, and regulatory officials. Underlying the eradication program's expected benefits was a premise that the program would "liberate" mango growers, including those resource-poor peasants, from the dependence on local packers or abusive coyotes who had access to the mandatory HWT. Given this, prior to the entry to the field, I had held a working hypothesis that the packers equipped with the treatment device might see the pest eradication program as a threat to their business, because establishment of PFA in southern Sinaloa means termination of the required HWT.

My probing questions asked of several key informants, including packers, elicited mixed responses. A few representatives of the PS regulatory authorities supported my view, pointing out that the packers were unhappy with the program. For those who had to keep the PS regulation running, the account that the eradication program could benefit (i.e., liberate) underprivileged growers, rather than privileged large-scale growers or packers/exporters, would make the justification for the program more persuasive and appealing to the broader public (e.g., tax payers, or non-farming populations affected by the regulation). However, the rest of opinions of the interviewees, including those of packers, did not conform to the hypothesis. The packers/exporters, especially those who were producing mangos on their own, seemed to rather welcome the PFA, because it could reduce the production costs to operate HWT. In addition, given the increasing demands for mango supply, the packers (especially "pure" packers who do not grow mangos on their own) would continue to need stable supplies of good-quality fruits from trusted growers, whether private landowning farmers or peasants. A manager of a packinghouse with a sizeable grove in production mentioned that its production had been in decline and he would need to increase supplies from outside. Among my interviewees, a typical packer's account, including that of this manager, was that to build and maintain longstanding trust, the packers should treat growers in proper ways by providing good returns. This was especially important because the local packers and processors were competing with each other to secure quality fruits from outside growers. The competition was harsh and tricky—although the packers would make an agreement on a general purchase price prior to a harvest season, nonetheless, such "gentlemen's agreements" were often and easily ignored. From the packers' standpoint, they also would have to assume considerable risks and burdens to respond to cumbersome requirements or standards on quality and other aspects of products from retailers and consumers in the developed countries. These accounts indicated that there was a complicated interdependent relationship between growers, packers, and buyers (Mexican intermediaries and U.S. importers) all of whom had to conform to PS regulations, although abilities for negotiations or to mobilize resources to obtain a variety of desirable outcomes (e.g., better prices, access to capital, markets, etc.) were not equal among them.

My observation indicated that the PS regulatory schemes in transition, which had been tightening controls over many aspects of mango production, could rather sustain the small-scale growers' dependence on the packers. In addition to the burdens of marketing and meeting quality requirements by importing buyers from the United States and Japan, the mango export first and foremost required clearance of PS regulations. As presented in the earlier chapters, the rules for production and transportation of mangos in and from Sinaloa were increasingly extensive and complex. This was more the case for growers or packers wishing to export fruits.

Under the current PS regulations, all mango growers must pre-register their groves prior to a harvest season every year. For export to the U.S. market, data of registered groves and growers must be sent to the USDA. Right before the harvest, all mango plantations must go through inspection by inspectors of the PS regulatory authorities, including CESAVESIN and third-party organizations. To have inspectors check fruits, growers and packers buying mangos have to notify CESAVESIN to register dates of their harvest and location of their plantations. At this registration, they have to pay fees to be used to administer the eradication campaign. Harvest processes have to be inspected by inspectors as well. No harvested fruits can be transported to a local packer without a document issued by CESAVESIN upon fee payment, which certifies the origin of the products because the packer cannot accept, process, or ship undocumented fruits. The certification document, and an endorsement by PS officials of proper treatment (HWT) at packinghouses, must be attached to every shipment of fruits destined to the United States. Without the certificate, the consignments are not allowed to pass the domestic quarantine inspection points (see Chapter 6) and, of course, the U.S. border inspection. Thus, the extensive network of regulatory procedures ensuring pest-free status of the commodity maintains the strict control over the harvest and packing processes. Also, some of the details of the regulations may be altered so that it becomes difficult for small-scale growers to be well informed about all the required procedures. Although, as I witnessed the representatives of the *ejidos* as well as the private landowning growers attend meetings with CESAVESIN,[45] it would not be easy for the peasant leaders to disseminate information regarding modified regulations to more than a thousand of their members.

The "pure" packers as well as the large-scale growers/packers were handling these regulations systematically in processes they use to secure fruits for procurement from local growers. To respond to the growing demands, they would need to procure mango fruits from growers without HWT capability. The local packers in southern Sinaloa employed field managers who would drive around the region to spot mango groves in good conditions and estimate dates of harvest. Once identifying a grove and its harvest date, the manager would contact the grower to negotiate for purchasing the fruits.

The relationships between the mango growers and the local packers might demonstrate resemblance with what Echánove and Steffen (2005) identified in *ejidatarios* growing mangos who sell their fruits to buyers (local packers or intermediaries) in the state of Nayarit, another major mango-producing state. These patterns varied in several aspects of procurement of fruits, including timing of offer to buy fruits, degree of "care" by buying packers of fruits on orchards, and availability of harvest labor and

[45] The representatives of the peasant and the private landowning-farmers organizations participate in the board of CESAVESIN.

transportation. In my brief field observation in Sinaloa, while I had a sense that there were varying yet similar patterns of arrangement, unfortunately my limited time in the field did not allow me to observe and distinguish details of arrangement between buyers and growers for procurement and harvest of fruits.

No matter how patterns of purchase were built between the growers and packers, a critical factor for both was the fact that due to the limited handling capacity of the packing facilities, the harvest, transportation, and processing, along with the clearing of PS regulations, must all be coordinated at the right moment. Although there were medium- or large-scale, independent (private landowning) growers who did coordinate all labor by themselves,[46] the local packers purchasing mangos from small-scale growers had to take care of all these harvest procedures. They organized harvesting teams to dispatch to mango groves and coordinate transportation of harvested fruits (which is provided by groups of workers specialized in transportation) to the packinghouse in a proper timing. While a grower would be informed about a date of harvest, he or she did not even have to go to the orchard. For small-scale peasants who lack sufficient family labor, it would be more practical to have a packer's harvest team pick fruits than arranging workers or harvesting fruits by themselves. For instance, an employee of the PS authority with whom I observed the on-site harvest inspection was growing mangos on his own grove in an *ejido* he belonged to. Although I missed the opportunity to ask

[46] This included caring for harvest workers. Since many harvest workers were laborers seasonally migrating from other states, the growers hiring them had to provide temporary lodging and food, which could add costs. A grower told me that, while he provided good care and decent accommodation to his workers, he knew that some of his colleagues were giving their workers much poorer care.

him how he would arrange harvest labor, I could reasonably infer that he also was relying on a packer harvesting team, while he, himself, was moving around for the inspection in the very harvest season.

A critically important factor was the timely clearance of PS regulations, without which all the harvest procedures could not proceed. Because CESAVESIN could operate only a few registration offices in the entire southern region, growers living in remote areas would find it bothersome to visit the sites only to handle PS regulations. Instead, going back and forth on pickup trucks between production areas and the CESAVESIN offices, or communicating with each other by cell phones and walky-talkies, I witnessed the field managers swiftly clear PS regulations to obtain the needed documentation and deliver them to harvest sites. For the field managers and packers, handling the regulations by him/herself in such a concentrated manner would be more secure, hence beneficial, than letting growers do the red-tape clearance.

Meanwhile, small-scale growers wishing to market mangos for export were likely to see some advantages in relying on the packers, including finding access to markets, saving labor for harvest, and clearing PS regulatory red-tape. Of course, despite these apparent benefits, in the context where the packers (buyers) were handling all harvest procedures, small-scale growers were likely to have little room for price bargaining, keeping them in a weaker position in the network of the mango commodity. During fieldwork, I heard complaints from several informants about prices of mangos virtually forced by the buyers. Although there seemed to be case-by-case variations, prices offered by the packers were inclusive of the harvest and transportation labors and the PS regulation fee. In other words, these costs were already “deducted” from sales of mangos that peasants earn.

Whether this price structure would be fair is another complicated question to address. A peasant might be interested in producing mangos for different reasons resulting from varying agro-ecological, technical, or financial conditions as well as factors that were not related to farming as such, including availability of non-farm employments. Whereas certain types of conventional agricultural productions—livestock in particular—would demand constant labor inputs, the mango crop might be a good option if the most labor-intensive harvest process could be “outsourced” to packers, allowing a grower to work for additional income. This is in line with past literature that has documented diversification of livelihood means through off-farm employments as alternative income sources in developing countries including Mexico (de Haan and Zoomers 2003; De Janvry and Sadoulet 2001; Echánove and Steffen 2005). For instance, a peasant who had recently started producing mangos told me that he would look for employment opportunities in other industries, including fisheries, another important economic sector of the state.[47] Also, conditions in which different ejidos sustain their livelihood appeared to vary considerably even when they were located in proximity. A peasant leader, who was also a regional cadre of CNC, taking me along on a visit to a few *ejido* communities to mobilize peasant members for a PRI’s party-related political event, suggested that whereas an *ejido* community seemed relatively better off, another

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[47] Indeed, the owner family of one of the largest mango grower/packer companies in the region also owned a business in shrimp production. However, past excessive catches and persistent poaching led to the depletion of shrimp and resulted in serious decline of the industry.

community in the next village was suffering from insufficient income sources. From the latter, many male community members migrated to the United States seeking employment opportunities. As noted earlier, and as demonstrated by critics, these livelihoods of *ejidos* under transition were the outcome of a series of political-economic reforms in Mexico including deregulation of *ejidal* lands. Especially problematic was that the series of reforms caused individualization of lives and dismantled communal ties within peasant communities (de Haan and Zoomers 2003).

10.6 Conclusion: Prospects of Benefits in Uncertainties

As mentioned earlier, literature in development sociology, especially that by AOA, has shown that peasants in developing countries adopt diverse measures for livelihood even under apparently similar condition caused by macro-scale social changes such as economic globalization (Long 2001; Long and Long 1992). Against theories that emphasize macro political-economic factors as structural determinants of actions of individual actors, AOA emphasizes actors' varying perceptions and active constructions of realities surrounding them, and their resilience. This perspective implies that an analysis to understand farmers' responses to agricultural globalization should consider possible alternative venues of livelihood, including non-farming activities, rather than examining a single commodity network or chain (in the present study, mango). Discourses justifying the prospects of economic benefits from the changing PS regulations and mango production should also be analyzed in this light.

On one hand, the current PS regulations, tightening the control over the production and transportation processes, may intensify or serve to sustain the growers' dependency relationship with the packers, forcing the supplying farmers to reconcile with their weak negotiation power. Even when the PFA in southern Sinaloa is established, the increasingly stringent PS regulations controlling many aspects of mango production can quite possibly make many growers opt to let the packers handle the red-tape, including payment of the mandatory fee to operate the eradication program. Risks and burdens pertinent to marketing the commodity to the export markets have been, to a large extent so far, borne by the packers, rather than growers. Most growers who cannot afford to invest resources for marketing are likely reluctant to embark on commercialization on their own. On the other hand, it is true that the fruit fly eradication campaign can “liberate” peasants from dependence on buyers and packers and open up the possibility for them to commercialize their products with better prices.

However, there seemed to be many uncertain factors surrounding the mango sector. For instance, the promising prospect of increasing demand for mangos has to be examined carefully. In southern Sinaloa, mango production seemed to be booming. Some farmers began planting mangos even in hilly remote plots (Figure 10-10). Although this might be an example of a good use of unexploited lands, access to the remote plots could hinder proper care of the trees, which would add fruits of poorer quality to the already saturated market. Furthermore, if the grower’s decision to produce mangos was not based on a strategic and precise cost-benefit calculation but rather the “jumping-on-bandwagon” motivation, then, in the near future supplies of mangos in this region were more likely to saturate, resulting in further decline in prices of the product. And if overproduction reduces the profitability of the mango production, then, the underlying rationale to continue the eradication program can be questioned. Meanwhile, if mango consumption in the United States, as accounted by the EMEX representative, shifts towards a more generic consumer type, the expected profitability of Mexican mangos can be questioned as well. The fact that the U.S. mango market has recently witnessed new suppliers, such as India, Pakistan, or Thailand, leading to harsher competition in the market, urges scrutiny of the projected profitability.

Furthermore, the resilience of the fruit fly pest adds uncertainty. Although the central region of Sinaloa had been already recognized by the Mexican government as pest-free, CESAVESIN was busy with an emergency action against reoccurrence of the pest when I was conducting fieldwork. Fruit flies are resilient. Even in the northern PFA recognized by the United States, the uncertainty of the pest did not completely disappear. A mango grower/packer showed me old HWT equipment left in his packing facility. As it had been a while since the area became pest-free, he could have scrapped the equipment. Nonetheless, he kept it because fruit flies might return—no one knows what will happen. And his statement “no one knows what will happen” became very convincing after I learned that, as mentioned earlier, his mango grove was badly damaged by a hurricane. Risks persist in any aspect of agricultural production.

Figure 10-8 New mango orchards on a remote hillside in Escuinapa, Sinaloa, Mexico
(Photo by author)

In the southern region, meanwhile, there was growing frustration among the growers and packers about stagnant progress in eradication and the mandatory program fee, which had continuously increased, despite their long term commitments. As the uncertainty of the pest eradication program (and continuous efforts and costs to maintain the pest free status) persists, a judgment over whether prospective benefits of the PS program will materialize remains difficult.

Given the intricate relationship between growers and packers and the intertwining political-economic backdrops surrounding the peasantry, along with intrinsic uncertainties in production of mangos and the pest's behavior, accordingly, it seems to be inadequate to reach a quick and definite judgment about whether PS regulations will "liberate" the small-scale mango growers from their dependence on the packers. Neither is it a simple task to evaluate the complicated relationships of interdependence between the small-scale growers and the packers. The economic prospects PS regulations are expected to bring should be discussed, not solely in terms of the relationship between the packers and the growers in the region, but by first, deliberating how to support, if necessary, livelihoods of peasant growers faced with opportunities and/or hardships brought by the global economy, and second, more broadly, situating the question in different contexts in which regulating the global agro-economy are calculated, justified, and observed in order to keep raising questions regarding its benefits and costs. Now that all the finding chapters have been completed, the next chapter, Conclusion, will address the research questions in detail based on the analyses of the findings.

Chapter 11

Conclusion

This dissertation research aimed to elucidate the workings of PS regulations enabling the export of Mexican mangos to the United States. PS regulations as material politics engage diverse and heterogeneous entities, and draw distinctions between pest/non-pest, simultaneously engendering a variety of socio-material orderings as their corollaries. In this concluding chapter, firstly, I will summarize the findings and analyses discussed in the previous chapters, along with responses to the research questions, which are:

[Question 1] How does the PS regulation network operate to draw distinctions between pest/non-pest, thereby enabling the export of Mexican mangos to the United States? Who and what devices, practices, or knowledge are applied in the development and enactment of PS regulations?

[Question 2] What values are associated with the PS regulation network, and what are the normative, moral, or ethical implications of the regulations?

[Question 3] How are the PS regulations in transition in Sinaloa changing economic prospects for mango growers and packers to tap into global markets of mangos?

Then, I will discuss the sociological significance of the present study, followed by a concluding reflection on the limitations of this research and suggestions for further research in the future.

11.1 Theoretical Framework and Review of Literature

Throughout this research I have intended to illuminate PS regulations for the export of Mexican mangos as material politics. The concept of material politics (Law and Mol 2008) draws attention to globalization as involving "material" processes. For instance, boiling pigswill to make hog feed, constitutes what Law and Mol call a "political technique" that draws distinctions between clean and not clean material and simultaneously links different places, thereby engendering multiple socio-material orderings on a global scale. Law and Mol postulate that there are two distinctive notions of politics: the first kind as political discussion or debate (following Hannah Arendt's political philosophy), and the second, a political process instantiated by more rigid material beings, such as sleeping policeman (following Latourian STS/ANT); neither single one suffices to embody material politics, but material politics is the "one that simultaneously foregrounds the relevance of materialities, whilst making it possible to explore differences and alternative modes of being" (Law and Mol 2008:135). Moreover, material politics extends its reach globally, beyond the boundaries of nation states, and is therefore bound by its technical capability of maneuvering objects, including humans or non-humans (Barry 2001).

Law and Mol's argument led me to posit that PS regulations for the export of Mexican mangos constitute a material politics, which engages human and non-human entities, with varying degrees of rigidity and flexibility (or immutability and mutability). PS regulations are enacted through and as very mundane practices, not necessarily in the form of disputes or contestations, and generates socio-material orderings among both human and non-human beings, including devices and places. Such ordering effects entail a variety of contingent distinctions (e.g., pest/non-pest fruits, clean/infested areas, appropriate/inappropriate pest control management), while simultaneously establishing links between distant places (e.g., a mango grove in Mexico and a supermarket's shelf where Mexican mangos are sold in the United States). Furthermore, these corollaries of the regulations would result in not only values, morals, or norms, but also asymmetrical consequences in economic opportunities, such as differing chances for mango growers or packers to have access to foreign or better market opportunities.

In the meantime, my study on PS regulations could be situated in several strands of literature, including works on neoliberal governance, systems theory, STS on scientific governance, and the sociology of agriculture and food production and consumption. The literature indicated that the neoliberal governance scheme for regulating agriculture and food provisions, in which the nation-state government is the principal regulator in society, are changing. This governance shift reflects differentiated social systems, such as law and science, which provide expert and technical knowledge bases to heterogeneous agents, including non-governmental entities. My theoretical foundation drawing on ANT was to grasp processes of assembling such heterogeneous agents, including non-human material beings. to enable PS regulations; yet, with the systems theory, it was anticipated that the assemblage of materially heterogeneous agents would not happen "smoothly," because of varying degrees of compatibility with each other resulting from differences in their operations.

11.2 Methodology

Methodologically, my study relied on the case study approach with qualitative data collected through ethnographic fieldwork in Mexico (July to November 2008 and

January to May 2009, nine months in total), combined with analyses of documents, such as statutes and scientific articles. Most of the data collection activities, besides the research of documentary data conducted in the United States, took place in Mexico, principally in the state of Sinaloa, supplemented with some extra travel in Mexico. The data collection activities entailed semi-structured formal as well as informal interviews, participant observations, and archival searches at libraries. The analysis of the collected data drew on both through—or, more accurately, dialectically combining—the "bottom-up" approach (i.e., by finding patterns among relevant anecdotes) and the "top-down" approach (i.e., by applying anticipated categories based on the theoretical framework). The writing proceeded by connecting the threads among the relevant anecdotes by tracing the historical and spatial network through which PS regulations have been developed.

11.3 Major Findings and Responses to Research Questions

Following detailed descriptions of the major actors, such as fruit flies and mangos, and the research site, Sinaloa, chapters 5 through 10 presented major findings and analyses. The first findings chapter (Chapter 5) elucidated how a certain fruit fly species was judged and determined to be a pest vis-à-vis particular fruit crops. I demonstrated two cases in which host statuses of Mexican Hass avocado and manzano hot pepper in relation to some *Anastrepha* fruit flies were debated and settled. The processes to "scientifically" determine pest-host relationships entailed somewhat controversial communications, revolving around uncertainties in the behaviors of *Tephritidae* fruit fly species; yet facts or knowledge about particular pests were taken for granted and kept concealed until uncertainties reemerged. The findings indicated that whereas science might rationally and meticulously calculate the potentials of specific pests as risks, science itself can shy away from being directly involved in making a legal or administrative decision; and rather it delegates the decision to other networks (systems). Scientific knowledge of host-status was translated into other social domains, such as law and administration. This translation was to build the network of control drawing the distinction between actors who control and those subject to control, entailing enactment of power. In the meantime, the remaining and concealed uncertainties about the pest would appear as controllable risks to those actors engaged in the rational calculation of hazardous events, whereas the same hazards could appear as uncontrollable dangers to those who are (deemed) excluded from calculation. I argued that sociological inquiries should keep elucidating in what contexts, by and for whom, a decision is made, and who will be affected by it, thereby shedding light on the decisive difference between those who are decision makers and those who are not.

The next three chapters (Chapters 6, 7, and 8) focused on processes through which PS regulations "materially" enacted themselves, engaging humans and non-humans, drawing the boundary between pest/non-pest, and enabling the export of Mexican mangos to the United States. Hence, the findings from these chapters, along with those of Chapter 5, lead to responses to the first research question, indicating that the PS regulation network has developed, not solely as the construction of legal statutes and administrative organizations, but also as a "material" embodiment, which a constellation of non-human beings, including devices, and biological agents constitute. More specifically, the export of Mexican mangos was first enabled by the post-harvest treatment technique using vapor heat, then fumigation with EDB replaced it, and finally, the currently most popular HWT followed in the 1980s. While the central idea of these post-harvest treatment techniques was relatively simple, that is, to kill immature insects in fruits, the legal and administrative procedures surrounding the treatment as such became increasingly complex, incorporating heterogeneous components and commands throughout the treatment procedures. Notably, this extending regulatory network for post-harvest treatments came to employ, not only statutes or verbal commands, but also coercive physical settings, such as the double screen doors to control movements of humans and non-humans.

PS regulations further developed and extended outside of packinghouses. Even while post-harvest treatments steadily enabled the export of mangos, efforts in research and development to control the fruit fly pests in the field continued so that eventually the national Campaign against fruit flies was established. The Campaign engaged a constellation of actors, including biological agents (e.g., natural enemies, sterile insects), physical constructions (e.g., roadside inspection points), and legal statutes. Thus, this regulatory network increased in internal complexity and extended its reach from farming areas to non-farming sites, involving both growers and packers and entities not related to mango production or exportation. In this extending regulatory network, non-governmental entities, including quasi-governmental organizations of growers and third-party certifiers, played critical roles, fitting squarely in a neoliberal politico-economic climate in Mexico. These organizations possessed a hybrid nature, combining characteristics of both government authorities and private sectors, with (supposedly robust) scientific technical expertise and a unique legal underpinning. I argued that this hybrid nature made these non-governmental agencies apt to connect and transcend different networks with different logics, enabling control over the vast PS regulatory network, especially in the case of Sinaloa, where the intensive pest suppression was under operation.

In response to the second research question, furthermore, as suggested by the material politics concept, the enactment of PS regulations did not concern solely the distinction between pest/non-pest, but also engendered a variety of ordering corollaries, including values, normative expectations, and senses of morality, which, combined with the use of more or less coercive physical constructs as mentioned above, served to dominate and discipline all those “touched” by the regulation to act in accordance with its globally valid commands to keep drawing distinctions between pest/non-pest. Importantly, therefore, even if the observed ordering effects were appearing and observed at very local and/or personal levels, they should be grasped as an enactment of the global regulations. In essence, the global regulations as material politics was embodied not merely as texts or verbal commands, but rather as a mobilization of heterogeneous material beings that communicate a normatively expected dominant pattern for humans’ and non-humans’ acts in an otherwise messy world.

Yet, this observation by no means indicates that the dominant disciplining effect was without conflicts. Although I insisted that the conflict communication as such should not be conceptually confused with non-order or disorder, the field of PS regulations—this “field” draws from Bourdieu’s concepts (Bourdieu and Wacquant 1992) as well—was rife with incompatible interests and hence prone to provoke explicit, often prolonged, conflicts, as presented in Chapter 9. Such conflicts seemed inclined toward morally imbued communication, especially when supposed normative expectations were not fulfilled. For instance, some mango growers who, whether deliberately or for other plausible reasons, did not practice required pest control measures, were morally accused with quite harsh words such as “thickhead.” This indicated, firstly, that although the logic behind the Campaign called for the responsibility of each individual grower at her or his grove, that imperative as such already assumed, though tacitly, collective responsibility held by all growers. Secondly, moral communication, while serving to complement the regulations’ disciplining effect, tended to problematize the whole personality, rather than specific features, of a person, and thus could obscure complex backgrounds that might hinder the person from observing commands of the regulation. Finally, and understandably, the frustration with those who were ignoring the rules, at least to some extent, reflected the slower-than-expected progress of the eradication program.

Indeed, as Chapter 10 detailed, discontent smoldered among Sinaloan mango growers as to the sluggish advancement of the eradication, which, when considering the pest’s resilience and other challenging factors, might be inevitable. And, the discussion developed in Chapter 10 provided a response to the final research question related to economic prospects the PS regulations might alter.

One of the working hypotheses I developed was that while mango growers in non-PFA areas in Sinaloa might welcome the expansion of PFA since they would be able to export fruits without relying on packers who had HWT equipment, packers might see the PFA as threat to their business. In particular, local small-scale growers, being dependent on the packers, might hope for “independence” from the packers upon completion of the pest eradication program. However, the relationship between the packers and growers, and the socio-economic contexts in which their relationships were embedded, were much more complex than my anticipation. The pest eradication program, a core activity of the Campaign, the costs (i.e., the campaign fee) of which each participating grower incurred, was launched with a rationale that the invested costs would eventually be compensated for by higher prices of mangos compared to those of other crops. Certainly, there was a good prospect of increase in the demand for Mexican mangos in the United States, their major export market. However, particularly in southern Sinaloa, such a high prospect ironically seemed to have led to an oversupply situation, which might depreciate prices of the fruit.

Another ironic fact was that while its northernmost geographical and agro-ecological conditions of Sinaloa were favorable for the eradication program, the same conditions were a disadvantage because when a mango-harvest season begins in the state last among the major mango-growing states, fruits from the competitors saturated markets and further suppressed their prices. The suppressed price of mangos was problematic for mango growers, especially small-scale farmers in southern Sinaloa, so-called peasants (*ejidatarios*) included, who tended to lack technical and financial capital, and nonetheless might have jumped on the bandwagon of mango production, given the prospect of better prices of the fruit. The increase in the fee to participate in the Campaign exacerbated this situation, despite the sluggish—as it appeared to growers who had to pay the cost—progress in eradication. The stagnant prices of mangos along with the increased fee could have made some growers unwilling to observe the regulations. Unfortunately, the logic of free-market's "supply and demand" by which the prices of mangos would be determined, and on which the hope for better market opportunities for Mexican mangos hinged, was beyond the control of CESAVESIN and third-party certifiers, which aptly maneuvered the field operations of PS regulations.

Despite the murky outlook for prices and the slow progress in eradication, apparently, mango production still attracted growers in southern Sinaloa. Growing mangos required much less labor than other conventional crops and livestock production. In particular, harvest, the most labor-intensive process, as well as some of PS regulatory "red-tape," such as the campaign fee payment, could be taken care of by the local packers. While some *ejidatarios* were embarking on independently marketing their mangos despite technical and financial challenges, many growers seemed to continue working with the packers and find other employment opportunities.

Given the above observations of the complex socio-economic contexts in which the livelihoods of growers were situated, I argue, while PS regulations, the Campaign program in particular, could definitely improve market chances for even small-scale growers, substantial challenges, including their dependence on packers, still remained, and had to be dealt with if such an economic prospect was to materialize as expected. Rather, I argue that the question as to whether and how PS regulations would alter the prospect of economic opportunities for those involved in mango production to tap into global markets requires a careful scrutiny into varying and complex realities surrounding the livelihoods of the small-scale growers, such as financial capital, access to technical assistance, or supplemental outside employment opportunities.

11.4 Sociological Significance of the Present Research

11.4.1 What insights did my research add to sociology?

What contributions, or new insights, could this research add to sociology, especially literature related to agri-food studies, globalization, and development studies and theories, including science and technology studies and systems theory? One contribution that I claim this study makes is that my inquiry has shed light on PS regulations as the principal theme, with a relatively unusual approach combining insights from both STS and a social systems theoretical framework. Although the globalization of agriculture and food production and consumption and the organizational and institutional changes enabling it, including global regulations and standards, have been keenly investigated in social sciences and in the sociology of agriculture in particular (Bonanno et al. 1994; Goodman and Watts 1997; Higgins and Lawrence 2005a; Lowe, Marsden, and Whatmore 1994b; McMichael 1994b), relatively few works have dealt with PS regulations as the main focus of study (Alvarez 2001; 2006; Knight 2005; Stanford 2002). In this regard, the detailed and comprehensive delineations of the operations and historical development of PS regulations have added, I believe, new insights to the literature of sociology of agriculture and globalization.

More specifically, however, my study has raised several sociologically significant implications: (1) there has been a shift toward the diffusion of control of agri-food networks from control by a nation-state government to a governance scheme involving more heterogeneous entities/actors; (2) expected specific roles of science and technologies in materializing the regulatory network have increased, leading them to acquire a major control ability, or what is termed "scientific governance"; (3) control abilities are not only *unequally* distributed among actors involved in a regulatory network, but also in *qualitatively different manners* in society (i.e., different components have different functions), which reflects their particular characteristics, that is, control is dispersed within functionally differentiated social systems.

Firstly, the recent literature in sociology of agriculture and food production and consumption and critical assessments of political-economy and political processes has incorporated increasing concerns about the shift toward governance from (nation-state) government (Dean 1994; 2010; Higgins and Lawrence 2005a; Jessop 1995; 1998; 1999). According to the governance concept of which central argument is to grasp, not a single controlling entity, but rather a multiplicity of practices and technologies, controls individual's conduct, including self-disciplining mechanisms drawing on ethical calls, as encapsulated as the term "governmentality" (Foucault 1978). The recognition of such a shift of the controlling mode was captured by sociological works in the 1980s through 1990s, which argued that global integration driven by multinational corporations under the capitalist agricultural development had undermined the national basis in regulating agriculture and rural spaces (Lowe, Marsden, and Whatmore 1994a). Interestingly, however, my study of PS regulations as a global regulatory institution elucidated significant roles that nation-state governments still maintain in its enactment. Meanwhile, my findings indicated that national PS regulations were enmeshed within the "hierarchically" as well as "horizontally" arranged organizational and legal framework extending from the international to local scales, and that the quasi-governmental bodies came to play significant roles in PS regulations in Mexico. These observations fit squarely with recent literature observing governance that has illuminated increasing roles of new regulatory bodies, including international organizations and non-governmental "third-party" certifiers, towards which centers of control over the agri-food provision network has been shifting (Hatanaka, Bain, and Busch 2005). Furthermore, in the literature of sociology of agriculture and food production and consumption, there has been a “consumption turn” arguing that consumers, and the retail sector as a mediator and materializer of their interests, became an influential determinant in shaping and steering the ways agro-commodities would be produced, and how they were consumed (Busch and Bain 2004; Goodman 2002). Nonetheless, in my case of PS regulations, direct influence on the very regulation’s operation from retailers or consumers did not seem substantial. Although the Campaign against the fruit fly rhetorically mobilized consumers’ interests and benefits as its justification, the principal discourse to justify it was that Mexican growers bound by trade limitation were its beneficiaries, thus, contrasting with the above literature.

What does the compatibility of my findings with some, and incompatibility with other, trends of agri-food globalization, especially the governance shift discussed in the literature, indicate? I argue that sources of and demands for legitimacy of global agri-food regulations have become diversified, hence, different regulatory networks are constituted and composed in varying and heterogeneous ways, contingently depending on types of object dealt with and interests of involved actors. For example, whereas food safety concerns provoked by occurrences of bovine spongiform encephalopathy (BSE) in Japan were supposed to be handled by scientists convened under a national government agency (Tanaka 2008), other cases of establishing regulations, such as product development, quality standards, or certifications of organic agricultural products in the United States, were undertaken by retailers or third-parties (Busch and Bain 2004; Flynn, Marsden, and Ward 1994; Freidberg 2004; Guthman 2004). As elucidated through my research, regulations, such as PS regulations, can comprise a constellation of robust monitoring schemes, which span varying scales/spaces (Mutersbaugh 2005) and serve to self-discipline conduct of individuals. Yet, the monitoring activities were embedded and enmeshed within the locally specific socio-economic conditions, such as the interdependence relationship between mango packers and growers, and extrinsic biological factors such as the resilience of the fruit fly pests. Thus, contingent and locally-specific arrangements and/or distributions of resources, interests, and agri-ecological factors would make up an internally heterogeneous and complex composition of a specific regulatory network, which could differ substantially from one another. Finally, the local embeddedness of the regulation suggested, as mentioned above, that careful examination is needed as to how likely and plausible discourses claiming benefits and beneficiaries, as well as cost and risk distribution, are, since locally specific conditions can hinder the supposed benefits from materializing.

Secondly, in close relation with the first theme regarding governance, STS proposes the concept of scientific governance (Irwin 2007) to critically examine the relationship between political/legal/administrative decision-making and science as a truthful and trustful knowledge base for the former, especially to deal with risks or hazards. My study of the material politics of PS regulations has illuminated a couple of themes that resonate with this line of inquiry drawing on scientific governance. For example, the regulatory network developed as an assemblage of heterogeneous actors, mobilized through a constellation of practices, including discursive commands, technologies, and physical constructions. The regulatory network as a techno-scientific assemblage, thus, served to discipline all those involved in it through, on one hand relatively coercive physical settings, and on the other hand, supposedly objective scientific knowledge that serves as authoritative legitimacy by which individuals develop self-disciplining normative and ethical senses conforming to global science-based regulations.

Another important finding related to "boundary work," which demarcates science and non-science (Gieryn 1983; 1999; Jasanoff 1987). As the principal legitimate source of objective knowledge of "natural" worlds that steers political/administrative decision-makings, science attempts to draw a boundary with other domains of society. For instance, some entomologists perceived politico-economic interests permeating into the making of a scientific judgment as distorting objectivity. Yet, boundary works are not premised on a static and pre-established boundary, but rather presume a continuous enactment of demarcation, which may be murky and shaky. Thus constructed scientific knowledge may be based on suspended assumptions in the phenomenological sense (Berger and Luckmann 1966), as witnessed with the cases of tacitly assumed "immunity" of manzano hot pepper to fruit flies (Chapter 5), and of Probit 9 mortality, which has long been applied without scrutiny as a tacitly accepted risk tolerance level of pests (Chapter 6). Such implicit infusion of suspended assumptions into the making of scientific knowledge would call for critical assessment of the claim that scientific knowledge serves as a value-neutral basis for risk governance.

Thirdly, as indicated by literature in STS and scientific governance as well as works in sociology of agriculture and food drawing from STS, there is always asymmetry between those who are involved and those not involved in making (risk-related) political decisions (Irwin 2007). The asymmetry in scientific decision making often reflects the division between scientific experts and non-experts, lay or "engaged citizens." Historically, STS scholars have been critical of certain types of discourses revolving around relationships between scientific experts and non-experts, such as the "deficit model of public understanding of science," which disdains "lay" people's capability of understanding scientific knowledge (Massimiano and Neresini 2007). As science has come to affect every aspect of the modern technologized life with potential hazards, whether environmental impact, food safety, or other technologically induced disasters (e.g., nuclear accidents), its "public" nature drew massive attention, resulting in attempts, such as consensus conferences, to engage the public in techno-science-related political decisions (Fujigaki 2002; Kobayashi 2002). These efforts meant to mitigate the concern, if not completely abolish it, about the asymmetric relationship between those in influential positions in risk-related policy making, such as scientific experts and technocrats, and those who are not, and thereby build more "democratic" ways to construct scientific knowledge and political decision making informed by it.

However, different actors' asymmetrical degrees of engagement in risk-related science and political decision making, which juxtapose scientific/technical experts and non-scientific "lay" people, might also indicate differentiated expectations for different actors in the decision making. For example, the Risk Analysis scheme, which has become a standard model in risk-related governance (Yamada 2004) consists of scientific risk assessment, political/administrative risk management, and risk communication, presuming varying roles and responsibilities of different actors. Further, when we consider that even scientists dispute a scientific "fact" (e.g., whether prion was the pathogenic agent of BSE was contested), it could be insufficient to frame only the asymmetry between "scientific experts" and "lay people." Rather, I would argue, based on the systems theoretical perspective, it is more appropriate to grasp these apparently asymmetrical engagements in making science-based risks-related decisions as corollaries of different networks (systems or fields) that differ in their programs and simultaneously have their limitations. For instance, my examination of the risk management decision making regarding importation of Mexican Hass avocados to the United States also indicated that science was shy about making the administrative decision over relaxing quarantine restrictions on the commodity.

Following Luhmannian systems theory, I would argue that the above observation is an indication of a functionally differentiated society, which is, according to Luhmann, the hallmark of modernity. The concept of functional divisions, or functionalism, originating from the division of labor of society by Durkheim and inherited from Parsonsian structural functionalism, would remind many sociologists of the analogy with a living organism that posited "basic functions" as a causal mechanism to fulfill the needs in order to sustain the integrity of the organism's body (Collins and Makowsky 2005). Luhmann and his followers departed from this model and formulated it as a scheme with which to find alternative solutions that fulfill a certain condition (Nagaoka 2006). For instance, science as a subsystem of society would be posited to fulfill communications that distinguish truth/not-truth. Modern society is characterized with a constellation of differentiated functional systems (networks or fields) that operate in different conditions that each system has to fulfill. A system *may* serve to feed solutions into other systems,[48]

[48] Collins and Makowsky (2005) explain the basic functionalist premise as follows: "The various parts of a society . . . *all* serve functions for the other institutions, and they exchange these contributions for mutual support" (190, emphasis added). This understanding of functions, typical among Angrophone sociologists, is apparently similar with yet decisively different from Luhmann's in that in the former *all* functions are

thus creating inter-reliance among systems. For instance, scientific knowledge may be used as a legitimate basis for legal or administrative decision making.

Also, drawing on evolution theories, Luhmannian systems theory postulates the possibility (not necessity) of further differentiation within a system, that is, subsystems, which increase internal complexities. Although in sociology since the nineteenth century, evolution has often been equated with pre-determined "progress," contemporary systems theory has abandoned this perspective and grasps it as a contingent process consisting of variation, selection, and (re)stabilization (Luhmann 2009a). In this scheme of evolution, within a system, small variations (i.e., distinctions) selected more or less by chance eventually engender a relatively stable subsystem (subcomponent).

The empirical question or interest of this functionalism, however, resides not simply in explaining how well a depiction of social phenomena fits this model of inter-reliance between systems (thereby implicitly justifying status quo), but in elucidating what is concealed or ignored, whether conflicting interests of some people or uncertainties of the "natural" world, in the apparently "harmonious" connections among different systems. And, this interest in concealment and ignorance is encapsulated as a simple but vital question continuously asked in sociology from its outset: "what's behind all this?" (Luhmann 1998:77). Given this conceptualization of differentiation, I make the case that PS regulations intersect with different systems and are supplied with foundations of their legitimacy, such as "objective" scientific knowledge, legal underpinning, and calculation of economic benefits, and so forth. Following Callon's

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presumed to serve to sustain the whole society, whereas in the latter whether and how a functional system serves others is contingent.

terminology (Callon 1986), this process is one through which “feeds” from different systems are assembled though “problematization, interessment, enrollment, and mobilization” involving non-human beings, including physical constructs.

However, the hybrid characteristic of PS regulations comprising internally differentiated subcomponents, constituted as an assemblage of different institutional bases with the technical capability of enacting itself physically, which materializes itself as “power” disciplining everything involved, is an outcome of concealment and simplification of uncertainties of the workings of “nature” and perhaps conflicting interests. PS regulations might be based on scientific knowledge established by halting further contemplation of uncertainties of the pest’s behaviors; the regulation might also have overridden interests of resource-poor peasants who were unwilling to pay further costs, and the meticulous protocols might create conflicts between packers and regulatory inspectors.

All these considerations relate to a diagnosis of how risks are dealt with in society. One challenge faced by governance in modern society, especially in its relationship with the natural world, lies in handling of risks, which have extended the range of people affected by potential hazards beyond boundaries of nation states and political-economic statuses, or social classes (Beck 1992). According to Beck, risk in modernity results from growing technical capability to maneuver material around the world and make it predictable, which has ironically resulted in technologically induced unpredictable disasters. Yet, furthermore, governance of late modern society was meant exactly to solve this problem by calculating forcibly—as it were—this apparently incalculable unpredictability, thereby formulating it as a calculated risk (Dean 2010). Thus, the risk concept always resides with active calculation of hazardous events (Komatsu 2003; Luhmann 1993). And, in modern society, this rational calculation seems to be undertaken largely if not solely by science, rather than other social systems such as religion or art. This almost exclusive reliance on science as the calculator of risks, based on its expected capability to establish objective knowledge about nature, might be a reflection of the historical development of modernity. Latour (1993) posited that there was a "Great Divide" preceding modernity, which marked the epistemological division between "nature" and (human) "society." This led science to differentiate itself from religion to take over the latter's exclusive privilege of interpreting the "natural" world and building knowledge about it, which other differentiated systems, such as law and political systems, eventually came to incorporate in their operations (Köpping 2002). A problematic consequence of this differentiation of modern society is that, as each system can react to what would happen in "nature" only according to its own program, their capacity is prone to be overwhelmed by uncertainties (Hijikata 2002), which could eventually reemerge, as specifically demonstrated in Chapter 5. Risks, in this sense, are handled in a very paradoxical way in modern society—while handled as if they are calculable, in fact that apparent handleability is only on the basis of the limited capability of each system.

11.4.2 Limitations and directions of future research

My discussions above thus have shown that the sociological significance of this research is situated in various contexts of literature including sociology of agriculture and food production and consumption, development and globalization, and STS and diagnosis of modernity based on the systems theoretical perspective. All the findings and analyses were intended to elucidate, on one hand, some stories of what enables mangos imported from Mexico, commonly found in a supermarket in the United States, and, on the other hand, sociological implications of PS regulations. Meanwhile, obviously, there are limitations or weakness in the way I conducted this research and elicited the conclusions, as suggested in Chapter 3 (Methodologies).

To begin with, the case study approach is not intended to provide findings that can be generalizable across different cases. In this regard, it is essential for future research endeavors on global regulations, such as PS regulations, to expand geographical as well as thematic scopes of inquiry (e.g., regulations over other products, other pests), in order to examine variability as well as commonality across cases, to deepen understanding of processes associated with the globalization of agriculture and food production and consumption.

Also, my qualitative research methods did not provide accurate quantitative assessments of the impact of PS regulations. The recruitment of the informants relied on a convenient and snowball sampling strategy, because of which the obtained data were likely to be biased, especially toward “elite” perspectives. Thus, my study had virtually no information to estimate how many farmers would benefit from participating in the PS program or how much costs and benefit the regulation would generate. Since such information and analysis can be particularly pertinent to more “practical” contributions by sociological inquiries to policy-making, it will be beneficial and necessary to conduct systematic survey research for obtaining better quantitative estimates of perceptions, opinions, or concerns that stakeholders, such as mango growers and packers, embrace about PS regulations in Sinaloa and Mexico.

The last methodological limitation was that despite my claim that the ordering effect of PS regulations should be grasped as an incomplete status, this study can only capture it as a static writing. Nonetheless, I argue that the concept of ordering has an important theoretical implication that my observations and delineations of PS regulations continue to be subject to (re)interpretation, and thereby remain "incomplete." I hope that future readers will add fresh insights from this study to the literature of sociology.

Meanwhile, one may ask if this specific research could provide "practical" or so-called policy suggestions. To that question I would respond, for example, by insisting that the research illuminating the frustrations and struggles of some mango growers to meet the regulatory requirements should be alleviated by providing technical or financial support. Or, I might also suggest that publicity of the PS program, especially activities in urban residential areas, be more extended to inform people living there. While I believe that these suggestions are important, sociologically informed "practical" suggestions of this research based on the abstract argument on the consequences of modernity is to remind us that society has still limitations in its handling of risks. No matter how technically sophisticated it has become, society can handle uncertainties of the "natural" world only by assembling, reducing, and concealing its uncertainties, which may remerge. Nonetheless, the same modern society tends to pretend to be able to appropriately handle these uncertainties, yet in doing so, whether implicitly or explicitly, attributes and distributes responsibilities, costs, and moral/ethical duties to different actors or entities.

To conclude this dissertation, sociological inquiries can and should keep attending to who or what are supposed to bear burdens and costs in order to make possible the global-scale provision of foods and agricultural products, including "exotic" ones, such as mango. I believe that research endeavors to shed light on mechanisms behind the globalization of agriculture and foods, which entail mundane material practices and engender orderings of the world while concealing domination, conflicts, and costs, will remind us that the plethora of foods we enjoy cannot be taken for granted and is in fact unlikely to happen. Indeed, a Japanese word to express appreciation, *Arigatai*, signifies that the world that allows us to live is a very unlikely occurrence. I appreciate, or feel *Arigatai* about, the fact that mangos are produced and delivered from Mexico, and made available on a shelf of a supermarket in the United States.

Appendices

Appendix 1: Organizations contacted and visited for the study

Appendix 2: Interview guide

Appendix 3-1 Outline of NOM-023-FITO-1995

Appendix 3-2 Outline of NOM-075-FITO-1997

Appendix 1: Organizations contacted and visited for the study

Name of organization*	Type of activity	Location (State) **	Interview	Participant observation	Archival search	Remarks
Governmental agency						
Direction General Plant Health, National Service of Agro Alimentary Health, Safety, and Quality (SENASICA), Ministry of Agriculture, Livestock, Rural Development, Fisheries and Food of Mexico (SAGARPA)	Regulatory administration	Mexico City (Federal District)	Yes			Headquarters of fruit fly control program in Mexico
SAGARPA Regional Delegation office in state of Sinaloa	Regulatory administration	Culiacan (Sinaloa)	Yes	Yes		Regional office in Sinaloa of Ministry of Agriculture of Mexico
Fruit fly mass-rearing plant (Moscafrut)	Regulatory administration/ Research	Tapachula (Chiapas)	Yes	Yes	Yes	Plant for mass-rearing of sterlile fruit flies and biological control agents (parasitoides); engaged in research as well
Sanitary Regulation, State Government of Sinaloa	Regulatory administration	Culiacan (Sinaloa)	Yes			State government's agency in charge of health and safety administration
International Service (IS), Mexico Area III, Animal and Plant Health Inspection Service (APHIS), US Department of Agriculture (USDA)	Regulatory administration	Zapopan-Guadalajara (Jalisco)	Yes			USDA-APHIS regional delegation in central Mexico in charge of certification of export packing houses
State Library of Sinaloa	(Archive)	Culiacan (Sinaloa)			Yes	

Name of organization*	Type of activity	Location (State) **	Interview	Participant observation	Archival search	Remarks
Para- / Non-governmental organization						
State Committee of Plant Health of Sinaloa (CESAVESIN)	Regulatory administration	Culiacán, El Rosario, Los Mochis (Sinaloa)	Yes			"Auxiliary" (para-governmental) organization in charge of phytosanitary field activities in Sinaloa state
Food and Development Resaerch Center (CIAD)	Research	Culiacan (Sinaloa)			Yes	Governmental research and education institute
National Institute of Forestry, Agriculture and Livestock Research (INIFAP)	Research	Culiacan (Sinaloa)			Yes	Governmental research institute
Foundation Produce	Research/ Technical validation/ Extension	Culiacán, El Rosario (Sinaloa)	Yes	Yes		Non-governmental oraganization engaged in agricultural technical development and extension
NORMEX	Regulatory administration	Uruapan (Michoacán)	Yes			"Third-party" entity for certification
State Committee of Plant Health of Chiapas (CESAVE CHIAPAS)	Regulatory administration	Mapastepec (Chiapas)	Yes			"Auxiliary" (para-governmental) organization in charge of phytosanitary field activities in Sinaloa state
Local Phytosanitary Board of Fruit Growers of Soconusco (JLSVFS)	Regulatory administration	Tapachula (Chiapas)	Yes			Growers group responsible for local level phytosanitary regulatory activities

Name of organization*	Type of activity	Location (State) **	Interview	Participant observation	Archival search	Remarks
Packer/exporter organization						
Mango Packers and Exporters Asociation (EMEX)	Regulatory administration	Zapopan-Guadalajara (Jalisco)	Yes			Exporters association (the only organization officially recognized by US as representing Mexican mango exporters)
Packer/exporter						
Mango packer/exporter/grower 1	Packing / Export / Production	Northern Sinaloa	Yes	Yes		Mango packer/exporter with production
Mango packer/exporter/grower 2	Packing / Export / Production	Northern Sinaloa	Yes	Yes		Mango packer/exporter with production
Mango packer/exporter/grower 3	Packing / Export / Production	Northern Sinaloa	Yes	Yes		Mango packer/exporter with production
Mango packer/exporter/grower 4	Packing / Export / Production	Southern Sinaloa	Yes			Mango packer/exporter with production
Mango packer/exporter 1	Packing / Export	Central Sinaloa	Yes			Mango packer/exporter
Mango packer/exporter 2	Packing / Export	Southern Sinaloa	Yes	Yes		Mango packer/exporter

Name of organization*	Type of activity	Location (State) **	Interview	Participant observation	Archival search	Remarks
Farmer organization						
Confederation of Agricultural Association of State of Sinaloa (CAADES)	Production / Regulatory administration / Research / Extension	Culiacan (Sinaloa)			Yes	State-level "umbrella" organization of private land-owning farmers
Agricultural Association in southern Sinaloa 1	Production	Southern Sinaloa	Yes			Local-level organization of private land-owning farmers
Agricultural Association in southern Sinaloa 2	Production	Southern Sinaloa	Yes			Local-level organization of private land-owning farmers
Fruit growers association in Chiapas	Production	(Chiapas)	Yes			
Communal land user group in southern Sinaloa	Production	Southern Sinaloa	Yes			Group of "ejidatarios" (members of communal land "ejido")
Regional office in southern Sinaloa of National Commission of Peasants (ejidos)	Production	Escuinapa (Sinaloa)	Yes			"Umbrella" organizations of ejidos
Communal land user group en Chiapas	Production	Tapachula (Chiapas)	Yes			Group of "ejidatarios" (members of communal land "ejido")
Worker organization						
Labor Union of Farm Wage Workers	Regulatory administration (labor union)	Culiacan (Sinaloa)	Yes			
Regional Peasant Commission (farm wage worker union)	Regulatory administration (labor union)	El Rosario (Sinaloa)	Yes			

Name of organization*	Type of activity	Location (State) **	Interview	Participant observation	Archival search	Remarks
Universities						
Faculty of Agronomy, Autonomous University of Sinaloa	Research	Culiacan (Sinaloa)	Yes		Yes	
Central Library, Autonomous University of Sinaloa	Research	Culiacan (Sinaloa)			Yes	
Bioscience Center, Autonomous University of Chiapas	Research	Tapachula (Chiapas)	Yes			
Southern Frontier College, Tapachula Campus	Research	Tapachula (Chiapas)	Yes			
Central Library, Autonomous University of Chapingo	Research	Chapingo (México)			Yes	
Institute of Geography, Autonomous University of Mexico	Research	Mexico City (Federal District)	Yes			

Appendix 2: Interview guide

Form M

Interview Guide (English)

[Introduction (common to all informants)]

- Ø Explanation of the research objectives and procedures including the precautionary measures for protection of human subjects' privacy and confidentiality
- Ø Explanation of the anticipated interview time (about 45 to 90 minutes)
- Ø Explanation of the consent to participate in the research

[Questions about informant's information (common to all informants)]

- Ø Questions regarding informant's basic data such as:
  - § Age, gender
  - § Contact address
  - § Organization he/she is or was affiliated with, roles or position, years of affiliation
  - § Educational achievement, other career experiences

Guía de la Entrevista (español)

[Introducción (común para todos informantes)]

- Ø Explicación del objetivo y los procedimientos del estudio, incluyendo las maneras preventivas para la protección de la privacidad y confidencialidad de participantes en el estudio
- Ø Explicación del tiempo anticipado de la entrevista (aproximadamente 45 a 90 minutos)
- Ø Explicación del consentimiento para participar en el estudio

[Preguntas sobre la información de los informantes (común para todos informantes)]

- Ø Preguntas sobre datos básicos sobre el/la informante tales como:
  - § Edad , Género
  - § Dirección del contacto
  - § Organización con la que el/la informante esté afiliado, posición y papeles, la duración de la afiliación
  - § Logros educativos y otras experiencias profesionales

(Continued to the next page)

[Questions for researchers engaged in development of PS technologies]

- What are/were your roles in the development of the technology?
- How did you come to be involved in the research to develop the technology?
- What were official rationales for carrying out the research?
  - What social/economic/cultural demands were underlying the research?
- What were your personal opinions about those rationales for the research?
- What technical and other social (e.g. legal, financial) challenges and/or controversies did you encounter in the research?
- How did you address those challenges?
  - What technical tools, scientific theories, or legal or financial rationale did you (try to) come up with?
- What benefits and/or potential problems do/did you think the technology you developed would bring about? Please provide both "official" accounts of and your personal thoughts about impacts of the technology to following groups of people:
  - Yourself
  - The entire Mexican nation; farmers; distributors (packers and exporters); their workers
  - US nation, farmers, distributors, consumers
  - Any other group of people the technique might impact on

[Preguntas para los investigadores quienes se han involucrado en el desarrollo de las tecnologías fitosanitarias]

- ¿Qué son/fueron sus papeles en el desarrollo de la tecnología?
- ¿Cómo usted se ha involucrado en la investigación del desarrollo técnico?
- ¿Cuáles fueron razones oficiales para ejecutar el estudio?
  - ¿Qué demandas sociales/económicas/ culturales sostenían el estudio?
- ¿Cuáles fueron sus opiniones personales sobre las razones oficiales del estudio?
- ¿Cuáles obstáculos técnicos o sociales (p.ej. legal, financiero) o controversias se han encontrados en el estudio?
- ¿Cómo usted trató de solucionar los obstáculos encontrados?
  - ¿Qué herramientas, conocimientos o teorías científicos, o razones legales o financieros usted propuso o trató de proponer?
- ¿Qué beneficios y/o problemas posibles usted piensa/pensaba las tecnologías las que usted ha trabajado generarían? Por favor provea los cuentos "oficiales" tanto como sus opiniones acerca de los impactos de la tecnología sobre los siguientes grupos de gente:
  - Usted
  - La población entera nacional, productores, empacadores/exportadores, y sus trabajadores de México
  - La población entera nacional, productores; distribuidores, consumidores de EEUU
  - Cualquier otro grupo de gente sobre cual la tecnología haya tenido impactos

(Continued to the next page)

[Common Questions for PS officials, Growers, Packers/Exporters, Packers' association, and Workers]

- Ø What are/were rationales to carry out your work?
    - § What "official" social/economic/cultural demands do you know are underlying your work?
- Ø What tools, devices, material (e.g. pesticide) do you use in the work place (field)?
- Ø What technical and social (e.g. legal, financial) challenges do/did you encounter in your work?
    - § How do/did you address those challenges?
    - § Do the measures work effectively?
    - § Any problems in terms of operation cost, labor condition to tackle the challenge?
- Ø What changes in your work place resulting from the PS technology do you perceive?
    - § Please tell me a couple of your memorable experiences concerning working with the PS technologies.
    - § Any changes in norms or values such as work ethic or unspoken rules?
- Ø What benefits and/or potential problems do/did you think the PS technologies would bring about? Please provide both "official" accounts and your personal thoughts on impacts to following groups of people (same as above).
- Ø What is your overall opinion about the PS regulation and technologies?

[Preguntas comunes para los oficiales fitosanitarios, productores, empacadoras/exportadoras, asociación de empacadoras, y trabajadores]

- Ø ¿Cuáles son/fueron razones para usted de su cumplir su trabajo?
    - Ø ¿Qué "oficiales" demandas sociales/económicas/ culturales sabe usted sostienen el trabajo?
- Ø ¿Cuáles herramientas, aparatos, materiales (p.ej. pesticida), usa en el sitio (campo) de su trabajo?
- Ø ¿Cuáles obstáculos técnicos o sociales (p.ej. legal, financiero) o controversias ha encontrado en su trabajo?
    - § ¿Cómo trató de solucionar los obstáculos?
    - § ¿Sus soluciones funcionan bien?
    - § ¿Hay cualquier problema en torno al costo operativo o condiciones labores para solucionar los obstáculos?
- Ø ¿Qué cambios en el sitio del trabajo usted percibe que resulte de la tecnología fitosanitaria?
    - § Por favor cuénteme unas experiencias memorables acerca del trabajo relacionado a la tecnología fitosanitaria.
    - § ¿Cualquier cambio en normas o valores tales como el ético del trabajo o reglas tácitas?
- Ø ¿Qué beneficios y/o problemas posibles usted piensa/pensaba las tecnologías las que usted ha trabajado generarían? Por favor provea los cuentos "oficiales" tanto como sus opiniones acerca de los impactos de la tecnología sobre los siguientes grupos de gente (igual que arriba).
- Ø ¿Cuál es su opinión general sobre la norma y las tecnologías fitosanitarias?

(Continued to the next page)

[Questions for PS officials]

- Ø What is/was your work regarding the PS technologies (HWT and/or PFA)?
  - § Please describe briefly the nature of your work.
- Ø How did you come to be involved in this work?
  - § Any qualification requirement to do this job?
- Ø What are impacts of the expansion of the PFA in Sinaloa?

[Preguntas para los oficiales fitosanitarios]

- Ø ¿Qué es/fue su trabajo relacionado a las tecnologías fitosanitarias (HWT and/or PFA)?
  - § Por favor describa brevemente el carácter de su trabajo.
- Ø ¿Cómo usted se puso a dedicar a este trabajo?
  - § ¿Cualquier calificación requerida para dedicarse a este trabajo?
- Ø ¿Cuáles son impactos de la expansión de las áreas libres de plagas en Sinaloa?

[Questions for Growers, Packers/Exporters, Packers' association]

- Ø Please describe briefly your business operation.
  - § Size of your business (yield, treatment capacity, sales, employment)
  - § History of your business
  - § Other commercial activities (production or processing of other crops, etc)
- Ø What do you know about PFA?
  - § Is PFA affecting your business? In what way?

[Preguntas para los productores, empacadoras/exportadoras, y asociación de empacadoras]

- Ø Por favor describa brevemente la operación de su negocio.
  - § Tamaño del negocio (rendimiento, capacidad del tratamiento, venta, empleo)
  - § Historia del negocio
  - § Otras actividades comerciales (producción o procesamiento de otros cultivos, etc.)
- Ø ¿Qué sabe usted sobre el área libre de plagas?
  - § ¿Es eso afectando su negocio? ¿En qué manera?

[Questions for workers]

- Ø Please describe briefly your work.
  - § Nature of your work and size of your work place
- Ø How did you come to work here?
  - § Any qualification requirement to do this job?
- Ø What tools, devices, material (e.g. pesticide) do you use in the work place?
- Ø What do you know about PFA?
  - § Is PFA affecting your work? In what way?

[Preguntas para los trabajadores]

- Ø Por favor describa brevemente su trabajo.
  - § El carácter de su trabajo y tamaño del sitio de su trabajo
- Ø ¿Cómo usted se puso a trabajar aquí?
  - § ¿Cualquier calificación requerida para dedicarse a este trabajo?
- Ø ¿Cuáles herramientas, aparatos, materiales (p.ej. pesticida), usa en el sitio (campo) de su trabajo?
- Ø ¿Qué sabe usted sobre el área libre de plagas?
  - § ¿Es eso afectando su negocio? ¿En qué manera

Appendix 3-1 Outline of NOM-023-FITO-1995

Components	Contents
Main objectives	v To establish PS regulations against major Anastrepha pests to recognize and protect PFA and ALPP*[1] Ø Subjects of control: 47 fruit plant species that are hosts for four *Anastrepha* species and Apple maggot fly (*R. pomonella*) , "host fruits" hereafter
Areas of application	v Commercial orchards of host fruits v Marginal areas (non-commercial orchards, backyards, national parks, ecological reserve and wilderness areas) with host fruits
Specification of regulatory activities	v Registration and certification of orchards of host fruits Ø Orchard owners or users register their acreage with host fruits and have verification v Organization Ø Campaign participants belong to a growers-organization*[2] that coordinates the Campaign including finance Ø Federal government funds activities in marginal areas
Technical specifics	v Trapping for pest monitoring , sampling of fruits in fields for pest monitoring, and identification of the pests v Mechanical-cultural control (collection of unharvested fruits, clean-up of orchards, etc) and chemical control (bait-pesticide spray) v Release of sterile fly and parasitoid (natural enemy for biological control) v Determination of pest-prevalence status of orchards Ø (Individual orchard level) Categories of status (pest-free, low, and high) based on detected "flies per trap per day" (FTD) Ø (Individual orchard level) Record ("IPM card") of pest status Ø (Regional level) Categories of status (PFA, ALPP and "Area under PS control") based on FTD v Measures to maintain and protect PFA and ALPP Ø Monitoring of the pest by trap Ø Regulation of transport of host fruits from outside Ø Emergency plan of intensive actions to contain pests occurring in PFA
Technical appendices	v Organization and Administration v Field operation v Identification of fruit flies v Automated information system for field operation v Quality control of trapping v Emergency plan for PFA v Supervision and evaluation of the Campaign

*1 NOM-023 also intends to establish "temporally pest-free orchard." But, to make the explanation simple, I will omit its description
*2 Organization called "auxiliary body" including Comité Estatal de Sanidad Vegetal (State Committee of Plant Health) (to be discussed in Chapter 8)

Appendix 3-2 Outline of NOM-075-FITO-1997

Components	Contents
Main objectives	v To establish regulations for transport of fresh host fruits to prevent spreading to PFAs and ALPP
Areas of application	v Commercial orchards, urban acreages, ecological reserve and wilderness areas where host fruits grow v Facilities of packers, processors, intermediaries, distributors and PS treatment companies handling host fruits, etc v General cargo and passenger transports, and automobiles v Accumulation and marketing centers v Luggage, bags or packages at *Puntos de Verificación Interna* (PVIs, Domestic Inspection Points), railway terminals, sea ports, airports, and border points
Pest-prevalence status and zones	v PFA, ALPP and "Area under PS control" (see NOM-023)
Pests subjects to control	v Four *Anastrepha* species, Apple maggot (*R. pomonella*) and Mediterranean fruit fly (*C. capitata*)
Host fruits subject to control	v "Fruits of absolute quarantine": highly susceptible host fruits for which no PS treatment exists hence under strict control Ø 20 plant species v "Fruits of partial quarantine": host fruits for which a PS treatment is available Ø 26 plant species
PS activities	v Sampling of fruits v Post-harvest treatments to transport fruits into PFA or ALPP from outside Ø HWT, fumigation (methyl dibromide for mangos) v Inspection at PVIs by PS authority (or approved) personnel v Issuance of PS certificate (based on IPM card to accompany transported products v Disinfection treatments of products at origin or PVI v Regulations of transport of fruits of partial quarantine Ø (Transport of fruits of absolute quarantine to PFA or ALPP is prohibited) Ø Requisites vary depending on origin and destination (whether from or to area under PS control, ALPP or PFA, or destined for export), but in most cases PS certificate or IPM card is required.

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Educational Institutions Attended and Degrees Awarded

Ph.D, Sociology (expected), Department of Sociology, University of Kentucky Dissertation: *Making Boundaries and Linking Globally: "Material Politics" of Phytosanitary Regulation on Mexican Mangos* (Advisory Chair: Dr. Keiko Tanaka), 2012

Bachelor of Science, Agriculture, Department of Environmental Science and Landscape Architecture, Chiba University, Japan, 1993

Professional Positions Held

Aug '10 (Current)	**Part-time Instructor** Department of Sociology, University of Kentucky
Aug '04 - Jun '08	**Graduate Research Assistant** Department of Community and Leadership Development, University of Kentucky
Apr '97 - Jul '04	**Technical Official** Ministry of Agriculture, Forestry and Fishery of Japan
Jul '93 - Jan '96	**Japan Overseas Cooperation Volunteer** Research in Programa de Frutales Deciduos, Instituto de Ciencia y Tecnología Agrícola, Labor Ovalle, Quetzaltenango, Guatemala.

Scholastic Honors

1. **Presidential Fellowship**, The Graduate School, University of Kentucky, July 2009
2. **O'Donnell Award for Academic Performance**, Department of Sociology, University of Kentucky, May 2009

2. **Student Paper Award**, "Striving at Interface: A Pilot Study on Actors' Perspective in Local Agri-Food Movement in Central Kentucky," Southern Rural Sociological Association, Feb 2005

Professional Publications

Peer-reviewed Journal Articles

1. Maya-Ambía, C., **K.Sakamoto** and L.A. Retes Camacho. 2011 "Diversificación de los Mercados Frutícolas Externos de México ante los Desafíos de la Globalización: El Caso de las Exportaciones de Mango a Japón [Diversification of Fruit Markets outside Mexico faced with the Globalization Challenge: Case of Mango Exports to Japan]" *México y la Cuenca del Pacífico* 14 (42):67-96 (Spanish)

2. Murase, H., T. Maeno and **K. Sakamoto**. 2011. "Factors for Transition towards Community Supported Agriculture (CSA) in Japan: Underlying Motivations and Challenges." *International Journal of Environmental, Cultural, Economic, and Social Sustainability* 7(5):199-214

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5. **Sakamoto, K**., Y.J. Choi, and L. Burmeister. 2007. "Framing Multifunctionality: Agricultural Policy Paradigm Change in South Korea and Japan?" *International Journal of Sociology of Food and Agriculture* 15(1):24-45

Invited Paper

1. Tanaka, K. and **K. Sakamoto**. 2006. "BSE-mondai-ni Taisuru Amerika-seron-no Han-nou: Kokusaikasuru Syokuhin-risuku-wo Hikaku-syakaigaku-no Siten-kara Kangaeru [American Public Response to BSE Crisis: An Examination of Globalizing Food Safety Risks from a Comparative Sociological Perspective]." *Kagaku* [Science] 76:11. (Japanese)